U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA, AGRICULTURAL EXPERIMENT STATION, THOMAS F. HUNT, DIRECTOR; CHARLES F. SHAW, IN CHARGE SOIL SURVEY.

SOIL SURVEY OF THE HONEY LAKE AREA, CALIFORNIA.

BY

J. E. GUERNSEY, IN CHARGE, JAMES KOEBER, AND C. J. ZINN, OF THE UNIVERSITY OF CALIFORNIA, AND E. C. ECKMANN, OF THE U. S. DEPARTMENT OF AGRICULTURE.

MACY H. LAPHAM, INSPECTOR, WESTERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1915.]

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LETTER OF TRANSMITTAL

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., October 20, 1916.

Sir: I have the honor to transmit herewith the manuscript report and map covering the survey of the Honey Lake area, Cal., and to request that they be published as advance sheets of field operations of the Bureau of Soils, 1915, as authorized by law.

The selection of this area was made after conference with the State officials cooperating with the bureau in the work of surveying and classifying the soils of California.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. D. F. Houston,
Secretary of Agriculture.

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SOIL SURVEY OF THE HONEY LAKE AREA, CALIFORNIA.

By J. E. GUERNSEY, In Charge, JAMES KOEBER, and C. J. ZINN, of the University of California, and E. C. ECKMANN, of the U. S. Department of Agriculture.—Area Inspected by MACY H. LAPHAM.

DESCRIPTION OF THE AREA.

The Honey Lake area is in the southeastern part of Lassen County, Cal. It comprises that part of the Honey Lake Valley within the State of California, small areas of adjoining hilly and mountainous land, and a part of Long Valley, which adjoins the Honey Lake Valley on the southeast. The included land area is 529 square miles, or 338,560 acres. The California-Nevada State line forms its eastern boundary, while the other boundaries are irregular, conforming in a general way to the limits of arable land.

Fig. 1.—Sketch map showing location of the Honey Lake area, California.

The Honey Lake Valley lies within the Great Basin, and was at one time included in an arm of ancient Lake Lahontan, which covered a large area of the Great Basin in eastern Nevada and adjacent parts of California. Within it lies Honey Lake, a shallow body of turbid, alkaline water about 100 square miles in extent. This sink receives the greater part of the water falling in the so-called Honey Lake Basin, which comprises approximately 2,660 square miles of mountain and valley land, lying chiefly in the State of California but partly in Nevada. Two drainage basins are represented in the Honey Lake Valley. The western part of the valley lies within the Honey Lake Basin proper, while the eastern part is included in an unnamed basin which receives the waters of Skedaddle Creek and other intermittent drainage ways.

The elevation of Honey Lake is approximately 3,960 feet above sea level, and the greater part of the valley lies at an elevation of 4,000 feet to 4,250 feet. On the west, just outside the area, Thompson Peak, in the Diamond Mountain Block, a part of the Sierra Nevada Range, reaches a height of 7,752 feet above sea level. On the north

the valley is bounded by the low, barren hills of the lava plateau which extends northward into northern California and Oregon. This valley is distinctly structural, rather than erosional. The valley floor consists mainly of vast areas of old lake bottoms and remnants of lake terraces. The remainder is of recent formation, chiefly of lacustrine or semilacustrine nature.

The northwestern part of the valley is partially isolated from the remainder by Bald Mountain, a complex remnant of the Sierras, and is known as the Susan River Valley, although it also is a structural rather than a river-formed valley. It receives the waters of Susan River and Gold Run, Lassen, and Piute Creeks, which, together with the flow of Willow Creek from the north, discharge on the Susan River delta. The soils of the Susan River Valley bottom and delta are recent deposits of lacustrine or semilacustrine nature. The numerous streams draining into this valley traverse a forested basin which extends back to high slopes covered with snow the greater part of the year. The district consequently has the most reliable water supply in the valley, and this advantage led to its early development. Drainage, however, is poorly established.

To the north of the main valley and about the base of Bald Mountain are extensive remnants of Lahontan Lake terraces. These terraces are well drained and highly productive, but as yet large areas are uncultivated, owing to a lack of water.

The Lassen-Milford district, a narrow strip of land lying between the sharp fault scarp of the Sierra Nevada Mountains and Honey Lake, is composed of a succession of modified terraces rising from the lake to the residual soils along the base of the mountains. This district, with its deep, sandy soils, receiving waters from seepage and from small streams flowing from the pine-clad mountains, has been developed to a considerable extent despite the lack of transportation facilities. The precipitous slope of the Sierras at this point affords only a small drainage basin, and not enough water is available for complete development. Bringing water from an outside source is rendered difficult by the uneven topography of the country and by the precipitous nature of the bordering mountains, from which torrential streams rush intermittently to Honey Lake and would make it difficult to maintain a high-line ditch. The protection from frost, due to the good air drainage afforded by the slope and to the modifying influence of the lake waters on the temperature, has earned for this district the title of "Fruit Belt." A narrow strip of recent lake bottom bordering the waters widens out east of the town of Lassen into an extensive flat, more or less affected by alkali.

The southern part of the area includes that part of Long Valley which extends from the vicinity of Constantia northward. This

region, because of similar physiography, is naturally associated with the Honey Lake Valley. In common with the remainder of the area, Long Valley consists of a structural trough between two abrupt fault escarpments. It is about 35 miles in length, with a valley floor about 2 or 3 miles in width. Long Valley Creek, which empties into Honey Lake, is a winding stream, in places aggrading and elsewhere degrading. That portion of the valley included in the area surveyed represents areas of old lake bottoms and terraces through which the creek has cut a deep channel and areas of recent lacustrine and stream-laid deposits bounded by steep alluvial fans and abrupt mountain walls. The pine-covered Sierra Nevada rises to the west; on the east the Fort Sage Mountains are typical of the barren hills of the Great Basin region. South of the limits of the area surveyed, Long Valley is very narrow and irregular. Two railways traverse this valley, the Western Pacific and the Nevada, California & Oregon.

The remainder of the area surveyed consists of an extensive arid plain, mainly east but partly north of Honey Lake, commonly known as the "East Side," and a peninsula extending into Honey Lake from the south, commonly called "The Island."[1] Both these areas are typical of the Great Basin region, consisting of old lake beds with a level to gently sloping surface, varied by areas of small dunes. They support a very sparse vegetation. Climatically this district differs materially from the remainder of the valley, having the very low rainfall and hot summers characteristic of the desert region. Little development has taken place here, the population being limited to a few pioneers, most of whom attempt little more than to make a livelihood while completing the necessary term of residence on their homesteads. All streams draining into this region rise in barren hills and are torrential during heavy rains and dry at all other times. Much of the land is affected by alkali and is in need of drainage. This part of the area is well supplied with transportation facilities, being crossed by the Nevada, California & Oregon, the Western Pacific, and the Southern Pacific Railways. Calneva and Stacy are stations on the Western Pacific and Southern Pacific, respectively, the latter station being the natural center of a small area of good land which needs only water to make it productive. Northeast of the lake, about Amedee and Wendel, are several hot springs which form one of the attractions of the valley.

Until recent years the Honey Lake Valley had extremely poor transportation facilities, the Nevada, California & Oregon Railway (narrow gauge) furnishing the only means of shipping products. This road was completed to Amedee in 1891 and has been slowly extended through northern California to Lakeview, Ore., its present

[1] These local terms are used throughout the report.

terminus. Service on this road has been somewhat improved recently. In 1909 the Western Pacific Railway was built through the valley, furnishing transcontinental service. During the summer of 1913 the Southern Pacific Railroad was extended from Fernley, Nev., on the main line of the Ogden Route, through the Honey Lake Valley. Susanville is located on this railroad. This line gives good shipping facilities to the East and to the Pacific Coast.

The principal town in the valley is Susanville, the county seat of Lassen County, which in the early days was a distributing point for the surrounding mountainous country. This town is unfavorably situated, however, being in the extreme northwestern corner and far removed from much of the best agricultural land. Its population in 1910 is given as 658.

Litchfield and Reyl are small stations, the former on the Southern Pacific, the latter at the junction of the Nevada, California & Oregon and the Western Pacific Railways. Reyl is well located as a transfer point, but development of this section of the Honey Lake area is retarded by lack of irrigation water. Other towns of the valley are Standish, the business center of a rich alfalfa district, but without transportation facilities, and Lassen and Milford, both of which are well located and surrounded by small areas of productive land, but which also lack transportation facilities. Doyle, in Long Valley, is a transfer and distributing point for the Nevada, California & Oregon and Western Pacific Railways.

Lassen County was created in 1864 from the eastern and northeastern parts of Plumas and the eastern part of Shasta County. In 1860 the territory subsequently included in Lassen had a population of only a few hundred. Its population is given in the census of 1910 as 4,802. The population of the Honey Lake Valley is at present probably a little over 2,000, of which about one-half resides in Susanville. Of the remainder, the greater number live in the northwestern part of the valley, while the population of the East Side and of Long Valley is very sparse.

CLIMATE.

The only reliable data on climatic conditions in the Honey Lake Valley are those recorded by the Weather Bureau station at Susanville. These are not applicable to the valley as a whole, being representative of conditions in the northwestern part, which receives not only a much greater but also a more evenly distributed precipitation than the remainder of the valley. In this section there is a wide variation from year to year in the amount of snowfall. In some years the fall may be as great as 4 feet, the ground remaining covered

four or five months, in others the fall is light and little snow remains on the ground for any considerable time. Somewhat similar conditions obtain in the Leman-Milford district and in Long Valley. The climate of the Leman-Milford district is modified by Honey Lake and is quite mild and agreeable, although on account of the high mountains to the west the winter days are very short. In other parts of the Honey Lake Valley the snowfall is light.

The winters generally are mild in all parts of the area and the summer nights are always cool and comfortable.

The East Side section differs materially in climate from other parts of the area. No data as to precipitation here are available, but the annual rainfall is approximately between 5 and 15 inches and is entirely insufficient for agriculture. Rain seldom falls during the summer months. During the winter there is very little snow, and snow seldom remains on the ground for any length of time. The summer months are warmer than at Susanville, but the humidity is very low and the air clear.

The limiting factor in orcharding in the valley is frost. At the Weather Bureau station at Susanville the average date of the last killing frost in the spring is reported as May 19 and that of the first in the fall September 23. The earliest killing frost in the fall recorded occurred September 5, and the latest in the spring May 25. The occurrence and severity of frosts, however, vary widely from place to place, with the altitude, topographic situation, and air drainage. Sloping land which affords free movement of the air is in general the least susceptible to frost. A few small areas of bottom land near the hills and bordered by bluffs also are protected from frost, but the level valley floor is undesirable for orcharding. The Leman-Milford district and the Island are favored by the modifying influence of the waters of Honey Lake. The climate of even the most favored spots in the valley is adapted only to the hardier fruits for commercial purposes, although such fruits as apricots and prunes thrive in some places. Winter injury to young trees, even of the hardier fruits, may occur. The growing season is short as compared with the greater part of California, and in general yields are somewhat lower, but the superior quality of certain crops compensates in part for the lower production.

Winds are an important factor in farming in some parts of the valley. The East Side is subject to severe winds from the west, which are at times very disagreeable and detrimental to crops. High winds occur also in Long Valley, where they do considerable damage by drifting the light sandy soils. Throughout the remainder of the area the winds are moderate.

The following table, compiled from the records of the Weather Bureau, shows the normal monthly, seasonal, and annual temperature and precipitation as recorded by the station at Susanville:

Normal monthly, seasonal, and annual temperature and precipitation at Susanville.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	32.4	60	1	3.45	4.65	7.01	16.55
January	31.1	58	-8	4.06	.45	4.30	22.52
February	34.4	66	-11	3.09	1.38	2.44	16.06
Winter	32.6	66	-11	10.60	6.48	13.64	55.13
March	39.6	72	10	2.21	.35	12.30	11.35
April	47.2	83	17	1.06	.34	1.14	2.41
May	55.9	88	24	1.35	.54	1.03	.79
Spring	47.6	88	10	5.05	1.42	16.47	14.71
June	63.9	94	21	.56	.05	1.74	
July	71.3	102	24	.16	.00	.53	
August	70.7	98	22	.23	.05	.16	
Summer	68.6	102	21	.91	1.10	2.44	
September	61.8	90	26	.63	.10	.60	.00
October	50.0	74	19	1.42	.40	1.99	1.21
November	41.5	64	11	2.43	1.71	.47	2.33
Fall	51.2	90	11	4.49	2.44	2.99	3.59
Year	50.1	102	-11	21.67	5.35	32.5	74.43

AGRICULTURE.

Prior to the gold rush of 1849 a few miners and trappers had entered the Honey Lake Valley, but no permanent settlement had taken place, the hostility of the Indians making expeditions into the country hazardous. In the early fifties a few pioneers made permanent settlements in the valley, making their livelihood partly by pasturing stock on the bottom lands and cutting native bunch-grass hay and in part by mining. Conditions were so unsettled[1] that agriculture was not developed intensively.

Records of attempts at irrigation date back to 1854, but in all probability the early efforts consisted only of the flooding of grass land. Potatoes were one of the early crops. As conditions became

[1] History of Plumas, Lassen, and Sierra Counties, Fariss and Smith. 1882.

more settled small orchards and gardens were planted, chiefly on lands naturally watered by streams or seepage, or on lands so near to streams that irrigation was easily accomplished.

The first important advance in agriculture occurred in the early eighties, when the development of the higher mesa lands by irrigation was projected and the Leavitt Lake Reservoir was built. Development of the Standish alfalfa district followed. Since that time the area under cultivation has increased very slowly.

An impetus has been given agriculture by the building of the Southern Pacific Railroad, and several plans for materially enlarging the cultivated area are projected. There is a general tendency toward more intensive systems of farming.

At the present time the principal crop of the Honey Lake Valley is alfalfa, which is grown on the bottom lands of the Susan River, where it is usually irrigated under riparian rights along this and tributary streams. It is also grown on the terrace soils about Standish, irrigated with flood waters stored by the Lassen Irrigation Co.; on the lake-bottom soils, the terrace lands, and slopes of the Lassen-Milford district; and in Long Valley, in part without irrigation. Two or more crops are cut each season, with an average annual yield on the better fields of 2 to 3 tons an acre. On the irrigated mesa lands alfalfa grows very luxuriantly, the stools being very heavy and closely set. Throughout the Lassen-Milford district a heavy stand is obtained when plenty of water is available and proper care is given the fields, but as a usual thing the crop is neglected and the stand is uneven. In the bottoms of the Susan River Valley a few fields are well cared for, but the majority are not level, are flooded carelessly, and as a result the yield is poor.

Many of the alfalfa fields would undoubtedly give larger returns if leveled and carefully checked and renovated. Checking for irrigation is in some places advisable, but the irrigated mesa lands in many cases produce such a uniformly dense stand under the present method of simple flooding that it is doubtful whether the outlay necessary to check the fields would be profitable. Many of the fields are badly infested with gophers, and checking and flooding would often aid in keeping this pest under control.

In nearly all cases the fields are pastured in the fall after the last cutting. The alfalfa crop is mainly fed to range cattle brought into the valley for the winter. Very little is baled. Prices for alfalfa fluctuate considerably, the price in the season of 1914 falling to $4.50 a ton. The average price is between $6 and $8 a ton.

Alfalfa seed is produced to some extent. The acreage harvested for seed varies widely in different years, depending upon the market price. The crop usually is grown on dry farmed mesa lands. The

yields range from 250 to 550 pounds per acre. The price of alfalfa seed fluctuates from year to year, averaging about 12 to 16 cents a pound. The seed is of fine quality.

The growing of other hay crops ranks second in importance to the production of alfalfa. There are extensive areas of native grass land in the river bottoms and on the Susan River delta. In a few places attempts have been made to improve these lands, but on the whole they have received no attention. Improvement usually consists of sowing the land to timothy, which, if not further cared for, soon gives way to the native grasses. Redtop also has been sown. Most of the grass lands are now in very poor condition, and the yields of hay vary widely.

On the delta lands of the Susan River areas of tule and coarse marsh grass are cut for hay and then pastured. These lands are watered in a crude and wasteful way under riparian rights and yield from 1 ton to 1½ tons per acre. The gross annual income from these lands is $5 to $8 an acre.

Wheat, barley, and rye are grown to some extent. Probably one-half the acreage in these crops is irrigated and one-half dry farmed. The wheat is not of the best quality. Two mills operate in the valley, but the flour is of low grade, and most of it is used by the farmers supplying the grain. Considerable flour is shipped into the area. Barley and speltz are thrashed, but not in sufficient quantity to supply the local demand. Some barley and rye are cut for hay. The season of 1915 showed a marked increase in the area devoted to grain, owing largely to the low price received for alfalfa the preceding season.

Potatoes are grown successfully, and a yield of 300 bushels per acre is not unusual. Some of the potatoes are of excellent quality. The production of small fruits and truck crops has not been developed, although the further development of these industries should prove locally profitable. A few attempts with such crops have given good returns. Strawberries are grown to a small extent about Lassen and melons near Litchfield.

Several acres of land below Amedee were planted to sugar beets a few years ago. Good yields are reported, but at that time transportation facilities were poor and the cost of handling the beets discouraged further production. The Southern Pacific now furnishes a direct means of transportation to the beet-sugar factory at Fallon, Nev., and it is probable that the crop could be grown profitably provided the Fallon factory were able to handle the beets produced.

A crop at present receiving some attention among the farmers of the East Side is sweet clover. Occasional wild plants make a luxuriant growth. Sweet clover does not produce as heavily as alfalfa

and the hay has a lower feeding value, but it has value as a pasture crop. Where alfalfa can be grown successfully it probably is to be preferred, but the clover will grow on soils so low in organic matter that it would be difficult to get a stand of alfalfa. On such soils the introduction of sweet clover would increase the organic-matter content, and the land could later be used for growing alfalfa. On the East Side inoculation of the new fields of clover or of alfalfa is desirable and perhaps essential in most cases.

Apples, pears, peaches, and cherries are grown in small tracts about Susanville and in the Janesville-Milford district. Apples of many varieties produce heavy crops of fruit of good quality without care. No orchards of commercial size are in bearing at the present time, but some planting on a commercial scale has been done in the last few years. There are some pear trees in the valley and conditions seem well adapted to this fruit, although the trees are subject to blight. A few small peach orchards are in bearing in the valley, and a number of plantings of a few acres each have recently been made. The orchards include several freestone varieties, and the product supplies the local market as well as some of the lumbering and mining districts in the neighboring mountains. The recent plantings have been encouraged by the high prices obtained for the fruit, but with the present rapid growth of peach orcharding the local market will probably soon be overstocked and markets will have to be sought elsewhere. The climate of the valley is rather unfavorable for peach growing, spring frosts and winter injury both tending to diminish production. Cherries of excellent quality are grown, but there are no orchards of this fruit. Cherry production seems to offer good opportunities, as good outside markets are available. Care is necessary in selecting orchard sites, which should be as free from frost as possible. The Royal Ann and Black Tartarian varieties do well. There are a few trees of English walnuts, apricots, and prunes in the valley.

The production of Concord grapes receives considerable attention. The industry is so young that few data with respect to yields are available, but the indications are that it may prove to be profitable.

Very little dairying is carried on in the valley. There is one small creamery at Standish and another at Susanville. The demand of the local markets for dairy products is not supplied by the farmers, and considerable butter is shipped in from Reno, Nev. With the recent improvement in transportation facilities, the development of dairying apparently offers excellent opportunities. The raising of hogs would be a valuable adjunct to dairying. Hog raising receives but little attention at the present time.

A serious pest at the present time is the Russian thistle, which is supposed to have been brought into the valley with feed imported for the teams used in recent railroad construction. The spread of the thistle is very rapid, the seed being scattered as the plants are blown over the ground, and the plant is now common in several parts of the valley. An attempt is being made by the State Horticultural Commission to eradicate this pest. Sheep eat the young plants. Cultivation tends to keep the thistle under control.

About four-fifths of the farms of the Honey Lake area are operated by owners and practically all the remainder by tenants. The average size of farms in the Honey Lake Valley is about 240 acres. The price of land depends upon the available water supply. Irrigated land about Standish is held at $90 to $120 an acre. Land in the Leavitt-Milford district is held at $20 to $75 an acre, depending on the topography and water supply. Bottom lands and grass lands are held at prices ranging up to $50 or $60 an acre. "Dry" land, that is, land without water rights, is valued at $5 to $25 an acre. Relinquishments on homesteads are available at prices ranging from 25 cents to $10 an acre. Several thousand acres in the valley are held under State scrip, which has not yet been listed. This fact has naturally retarded development.

Wages, as in most undeveloped districts, are high. Laborers are paid $2.50 to $3 when hired by the day, or about $40 a month, with board.

Dairying promises to become the main agricultural industry of the valley, based on intensive alfalfa culture and improvement of the natural grass lands. The fattening of beef cattle from the range probably will continue an important industry. Trucking and small-fruit growing are becoming important, and with factory facilities sugar-beet growing may be developed. The use of the delta lands for the production of intensive crops apparently offers good opportunities.

Obviously, the present extensive methods of farming do not contribute to the highest development of the valley. Not only are the returns too small, but the waste of water limits the development of large areas which only await irrigation to be made productive.

SOILS.

The present physiographic features of the Honey Lake area are the result of complex geologic activities associated with the formation of the Sierra Nevada and Cascade mountain ranges, and the formation, expansion, and later desiccation of ancient Lake Lahontan. The rocks along the western, southwestern, and southern border of the area consist of the granites of the Sierras, those along the

northern border of the basin from the great volcanic flows of late geologic time, and those in the interior of the unconsolidated deposits laid down in former Lake Lahontan and the later deposits spread over the lake deposits. The soils, therefore, have been derived from various materials and have been formed under varying conditions.

The area belongs mainly to the Great Basin region. A narrow belt along the western side at the base of the mountains lies within the influence of the Sierra Nevada. The former region is one of very low rainfall with an almost complete absence of soil leaching. The western belt has a higher rainfall, with more thorough leaching of the soil. The soils, therefore, except in the western part of the area and in the poorly drained lake beds and flats, are low in organic matter and high in soluble mineral material. They are gray to light brown in color and have a high percentage of carbonates. The soils along the western border of the area have a much lower percentage of carbonates and a higher percentage of organic matter.

The materials entering into the formation of the soils are derived mainly from acidic granites, though coming in part from basic igneous rocks, including basalts and andesites, and in part from other rocks of various kinds.

The material of the first group is derived mainly from quartz diorite or granodiorite or related rocks of granitic character, and is confined mainly to those soils lying along or below the marginal base of the uplifted Sierra Nevada. These include the steeply sloping or rough and rocky to undulating or rolling soils of the mountain slopes and foothills, with the more gently and uniformly sloping alluvial-fan and lake-terrace deposits lying below.

The material of the second group, including the soils identified with the effusive basaltic and andesitic rocks, occupies the plateau and mountain surfaces bordering the area on the north and northeast, with the included Bald Mountain district, and locally the adjoining smooth alluvial fan slopes.

The material of the third group is composed of lake-laid sediments derived from various sources. Much of it has been transported by streams from distant areas and has been reworked and distributed to a greater or less extent by shore currents and by winds. This material occupies the valley floor or lake basin, of flat to hummocky topography and associated broad flat to gently sloping terraces.

In addition to the above, the lake-laid sediments of the Lahontan beds, modified by chemical deposits from hot springs or lake waters, occur in relatively inextensive but conspicuous areas.

Regionally, the soils of the area are identical in part with those of the Sierra Nevada of the Pacific Coast region, in part with those of the great volcanic plateau of the Northwestern Intermountain region; and in part with those of the Lahontan Lake beds of the

Great Basin region, as these physiographic and geographic soil regions have been recognized and defined by the Bureau of Soils in previous surveys.[1]

The soils of the Honey Lake area may be classed, on the basis of origin, into seven general groups: (1) Soils derived from residual material; (2) soils derived from old valley filling material; (3) soils derived from material of the Lahontan beds, modified by chemical precipitates; (4) soils derived from recent lake deposits; (5) soils derived from recent alluvial-fan deposits; (6) soils derived from wind-laid deposits; and (7) miscellaneous material. These groups also have distinguishing topographic features as well as differences of origin. The various soils are separated, according to origin, mode of formation, color, topography, etc., into soil series, and each series is separated into soil types on the basis of texture, the soil type being the unit of classification. Minor variations may occur within the soil type, some of which are mapped separately and some merely pointed out in the soil descriptions, depending upon their importance and extent.

SOILS DERIVED FROM RESIDUAL MATERIAL.

The residual soils of the area have been derived in place by the weathering of the underlying consolidated rocks. They are confined to marginal parts of the survey identified with or contiguous to the Sierra Nevada Mountains on the west and southwest, the volcanic plateau on the north and northeast, the Fort Sage Mountains to the southeast, and the included Bald Mountain region in the northern part of the area. A large part of the land is rough or stony, has a shallow soil, is subject to drought, and is without means of irrigation. The residual soils of the area are classed with the Holland and Olympic series.

Holland series.—The Holland series includes soils derived from quartz-bearing crystalline rocks. They come in this survey from deeply weathered granodiorite and quartz diorite, which occur along the base of the Sierra Nevada. The topography is rolling or sloping to steep or mountainous, and rock outcrops are frequent. The soils are of a light-brown to brown color, and in this area are of light texture. The subsoils are deep and highly retentive of moisture. The series is represented by a single type, the coarse sandy loam.

Olympic series.—The Olympic series consists of brown soils with subsoils usually of similar or slightly heavier texture and generally of slightly lighter or more reddish color. These soils are derived from basic or quartz-free crystalline rocks. In this area they are residual from the basalts and andesites of the lava plateau of north-

[1] Bul. No. 96, Bureau of Soils, U. S. Dept. of Agriculture.

eastern California, which skirts the valley to the north, and in some cases from the lava rock which remains from the earlier volcanic activity in the Sierra Nevada region. The soils occupy table-lands, rounded hills, and steep, rocky slopes. They are shallow and are underlain at depths of a few inches or a few feet by disintegrated bedrock. Though a considerable range in texture, color, and other characteristics occurs, the Olympic soil in this area is mapped as one type, the stony loam.

SOILS DERIVED FROM OLD VALLEY-FILLING MATERIAL, MAINLY OF LAKE-LAID ORIGIN.

The old valley-filling soils are derived mainly from the lake terrace and older deposits of the lower and flatter lake basins. The origin of some of this material can be quite definitely established, but the greater part of these deposits is derived from an undetermined variety of rocks. The soils derived from these older sediments have been modified to a varying degree by weathering in place of the underlying sediments and by leaching and percolation of surface and subsurface waters. The material, while not in all cases undergoing noticeable erosion, is in process of degradation rather than accumulation and usually is characterized by a tendency toward the formation of subsoils of heavier and more compact character than the surface soils, except where they are underlain at shallow depths by stratified sediments of coarser and more porous texture.

There is included with this group a soil of somewhat different character. This consists of higher lying gravels with finer interstitial soil material, most of it probably very old. It is derived mainly from basic or quartz-free volcanic rocks of basaltic or andesitic character and is underlain by an indurated or more or less consolidated bed of gravel. This impervious substratum may consist in part of volcanic tuffs or breccias, and the soil material is associated with and resembles that of residual origin from consolidated rocks.

The soils in this area derived from typical old valley-filling material are classed with the Johnstonville, Standish, and Lahontan series. Of these only the Lahontan has been recognized and mapped in previous surveys. The higher lying material of volcanic origin is classed with the Tuscan series, which has previously been recognized in certain surveys along the western base of the Sierras.

Johnstonville series.—The Johnstonville soils have been derived from material of the Lahontan Lake terraces, formed mainly from quartz-diorite detritus. The surface soils are light brown to brown and highly micaceous. The subsoils are of the same or somewhat lighter brown color, or are decidedly light gray from deposits of lime, though the material is not uniformly calcareous. Stratified

lake beds of fine or medium textured material, which may or may not include cemented layers, under lie the soil. The series occupies level or gently sloping benches, in some cases considerably modified by recent alluvial agencies (see Pl. I, fig. 1). Drainage is well established. The Johnstonville series is represented in this area by two types, the coarse sand, with a loamy phase, and the sandy loam, with a poorly drained phase.

Standish series.—The Standish soils have been derived from the material of the Lahontan terraces, having its source in a variety of rocks. The surface soil is brown, well supplied with organic matter and grades into a light brown subsoil, mainly calcareous. In the main, the surface is gently sloping, having been considerably modified by recent alluvial action. Surface drainage, except in a few low areas, is well developed, but underdrainage is in places restricted by compact or heavy layers in the subsoil. Alkali occurs in spots, chiefly in the lower lying areas. The Standish stony sandy loam, gravelly sandy loam, sand, sandy loam, loam, and clay loam are mapped in this survey.

Lahontan series.—The soils of the Lahontan series are typical of vast areas of the Great Basin region, consisting of extensive plains of light-gray and usually silty soils sparsely covered with vegetation. The series occupies the bottoms and terraces of Lake Lahontan and is derived from a variety of rocks, including volcanic ejecta, and has developed under poorly drained conditions. This fact, together with the high lime content, accounts for the light-gray color of these soils. The organic matter content is very low, and the lime content high. The soils contain more or less alkali. The Lahontan sand, fine sandy loam, loam, silty clay loam, and clay are mapped in the Honey Lake area.

Tuscan series.—The Tuscan series consists of brown to distinctly reddish brown surface soils and subsoils, the latter usually heavier and more compact than the surface materials. The material usually is shallow and is underlain by brown or reddish to gray, indurated or cemented gravels, or in some cases by volcanic tuffs or breccias. In this area the substratum locally may include andesitic tuffs, breccias, and more or less cemented, stratified lake-bed material. The topography ranges from sloping to steep and broken. In this area the Tuscan gravelly loam is recognized.

SOILS DERIVED FROM MATERIAL OF THE LAHONTAN LAKE, MODIFIED BY CHEMICAL PRECIPITATES.

The soils derived from the older Lahontan Lake sediments, modified by chemical precipitates from hot springs or lake waters, are grouped in the Churchill series. This series, while not extensive, is conspicuous, and has been recognized in earlier surveys.

Churchill series.—The Churchill series consists of materials corresponding to the Standish and Lahontan soils to which have been added by deposition from the waters of hot springs and of Lake Lahontan layers and irregular masses of calcareous tufa. This material is present in the nature of a hardpan at depths varying from a few inches to several feet. It occurs also over considerable areas of the Lahontan soils and in places in the Standish soils, as thin, fragmental layers, the included areas being undifferentiated where it is not of sufficient thickness, hardness or continuity to be an important factor in agricultural development. The Churchill series is represented by the stony loam, sandy loam, and loam types.

SOILS DERIVED FROM RECENT LAKE DEPOSITS.

The soils derived from recent lake-laid sediments, which may still be in process of deposition, have not been sensibly weathered, and occupy low, flat, poorly drained areas. They are classed in two series, the Carson and the Buntingville.

Carson series.—The Carson series includes dark-gray to black surface soils, with subsoils somewhat lighter gray to light brown in color and highly calcareous. Drainage is very poorly established, and large areas are inundated during long periods in wet years. Typically, the series consists of recent deposits having considerable depth, but developments occur in the Honey Lake area in which the subsoil below a depth of 18 inches to 3 feet consists of material belonging to the formation giving rise to the Lahontan series. The Carson loam, clay loam, and clay adobe are mapped.

Buntingville series.—The Buntingville series differs from the Carson series essentially in its lighter color of a brownish hue, and in having a subsoil which is not highly calcareous. While the soils are well supplied with organic matter, the content is not so high as in the Carson series. In the main, this series is poorly drained. Alkali occurs in places. The series is represented by the sandy loam, loam, and clay loam types.

SOILS DERIVED FROM RECENT ALLUVIAL-FAN DEPOSITS.

The soils of the alluvial-fan group are derived from recent deposits distributed mainly by minor intermittent streams as débris aprons about the margins of the valley. The soils of the group are characterized by smooth, uneroded surfaces, are undergoing aggrading and building-up processes at the present time, and generally are characterized by permeable subsoils not consistently heavier or more compact than the surface soil. They usually are well drained and free from alkali. The material has been derived from both the granitic and the later effusive basic igneous rocks. The recent-alluvial soils

are not extensive, but have somewhat locally been superimposed over the older lake-terrace and shore deposits into which they merge and from which they are sometimes differentiated only with difficulty. They are classed in the Hanford, Foster, and Stacy series.

Hanford series.—The Hanford soils are light brown to brown in color, deep, and well to excessively drained. The materials forming them have been washed from quartz-bearing crystalline rocks, consisting in this area of granodiorite or quartz-diorite. The series is represented by the stony sandy loam, gravelly sandy loam, coarse sand, and sandy loam types.

Foster series.—The Foster series has dark brownish gray or dark brown surface soils, friable and micaceous, grading into subsoils slightly lighter to light brown in color. The origin of the soil material is mainly the granitic rocks, but in this area material has been contributed also from the lava rocks and from the old gravels of the Jura River. Drainage is poorly established and some areas of the soils are overflowed for a considerable part of each spring. The series consists of alluvial-fan deposits. The sandy loam, with a dark-colored phase, is the only member of the series mapped in this area.

Stacy series.—The soils of the Stacy series are brown in color, deep, and friable. The materials giving rise to this series come from the basic igneous rocks of the lava region. In all cases the soils are well drained. The Stacy series occupies alluvial fans. It is represented in the Honey Lake area by the gravelly sandy loam and loam types.

SOILS DERIVED FROM WIND-LAID DEPOSITS.

The wind-blown soils consist of material derived mainly from lake-shore and beach deposits, varying widely in lithological origin. The topography is characteristically undulating or choppy, and surface drainage is not well developed, but owing to the prevailingly loose, porous character of the material water rarely or never stands on the surface. These soils are classed in one series—the Preston.

Preston series.—The Preston series includes shore dunes along the margins of ancient and present lakes and parts of lake terraces greatly modified by wind action. Two types are mapped, the sand, with a shallow phase, and the clay adobe.

MISCELLANEOUS MATERIAL.

The miscellaneous group includes areas, mainly of nonagricultural character, which can not properly be included with the other soil groups. Rough stony land is the only miscellaneous type recognized in this area. It includes local areas of Peat, shown by swamp symbols on the soil map.

The following table gives the name and the actual and relative extent of each of the types mapped in this survey:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Lahontan silty clay loam	40,115	14.9	Carson clay adobe	4,[illegible]	[illegible]
Olympic stony loam	40,[illegible]	14.0	Standish stony sandy loam	3,[illegible]	[illegible]
Rough stony land	40,073	12.7	Stony gravelly sandy loam	2,[illegible]	[illegible]
Preston sand	24,064	8.6	Standish gravelly sandy loam	2,[illegible]	.7
Shallow phase	8,256		Standish clay loam	2,[illegible]	.7
Johnstonville coarse sand	1,[illegible]	7.1	Tuscan gravelly loam	2,[illegible]	.7
Loamy phase	22,464		Hanford stony sandy loam	2,[illegible]	.7
Lahontan loam	15,[illegible]	4.9	Stony loam	2,[illegible]	[illegible]
Lahontan fine sandy loam	16,064	4.7	Standish sand	2,[illegible]	[illegible]
Standish sandy loam	15,744	4.7	Hanford coarse sand	7[illegible]	[illegible]
Carson clay loam	12,[illegible]	3.4	Foster sandy loam	[illegible]	[illegible]
Holland coarse sandy loam	9,792	3.0	Dark-colored phase	[illegible]	
Dark-colored phase	200		Lahontan clay	[illegible]	[illegible]
Johnstonville sandy loam	4,672	2.3	Dark-colored phase	[illegible]	
Poorly drained phase	2,[illegible]		Churchill sandy loam	1,[illegible]	[illegible]
Standish loam	5,[illegible]	2.0	Churchill loam	1,[illegible]	[illegible]
Carson loam	6,144	1.5	Lahontan sand	[illegible]	[illegible]
Buntingville clay loam	6,[illegible]	1.8	Hanford gravelly sandy loam	[illegible]	[illegible]
Churchill stony loam	4,224	1.4	Preston clay adobe	[illegible]	[illegible]
Buntingville sandy loam	3,[illegible]	1.3			
Hanford sandy loam	3,456	1.0	Total	[illegible]	
Buntingville loam	3,[illegible]	1.0			

HOLLAND COARSE SANDY LOAM.

The soil of the Holland coarse sandy loam is a light-brown to light grayish brown coarse sandy loam. The subsoil is heavier and more coherent and of a somewhat mottled, light-brown color. The admixture of coarse grains of quartz with the finer materials gives a soil which is friable and at the same time of good water-holding capacity. In places the texture is light, approaching a coarse sand. The subsoil is also retentive of moisture, though easily penetrated by plant roots. At any depth from 1 foot to 6 feet the material grades through decomposed rock into unaltered bedrock. But only in small areas does bedrock occur so near the surface as to make the type unsuitable for farm land.

This type occurs along the foot slopes of the Sierra Nevada. The topography is rolling to uneven and hilly, affording good air drainage and protection from frost, but making irrigation difficult. Owing to the elevation any extensive irrigation system is impracticable, and the greater part of the type remains in pine forest, only a small area being farmed.

Small areas are in fruit, alfalfa, and vegetable gardens, to all of which crops the soil is well adapted. Occasional small patches have

been cleared and are farmed to grain, and in places the sparse native grasses are pastured. The developed areas, however, represent variations of this soil; the typical areas are best suited to forestry.

The type is low in organic matter and requires fertilization for successful crop production. As mapped, it includes a stony or rock-outcrop variation, which is indicated on the map by rock-outcrop symbols and which is somewhat more extensive than the stone-free material. This variation differs from the typical soil mainly in the frequent occurrence of massive bowlders of granodiorite and in having a more irregular topography. It is practically undeveloped and for the most part in pine forest.

Holland coarse sandy loam, dark-colored phase.—A dark-colored phase of the type is recognized. The surface soil of this phase is dark brownish gray to black in color, micaceous, and very high in organic matter. It ranges from a sandy loam to a rather coarse sandy loam in texture, is friable, and well adapted to intensive cultivation. The soil grades into the underlying disintegrated granodiorite at any depth from 1 foot to 6 feet or more, and the unweathered bedrock ordinarily is found about 3 feet lower. Occasional outcrops occur. The subsoil, where not displaced by shallow bedrock, is of dark-gray color, grading into light brown or yellowish brown as the bedrock is approached. This phase of the Holland coarse sandy loam has a distinct character, and if it were more extensive would be recognized as belonging to a separate series.

The phase occurs in small depressed or sloping areas within or along the border of the typical Holland soils where seepage water collects. In most cases, the surface is fairly smooth and the slope slight to moderate. Natural underdrainage is poor. The surface drainage usually is restricted. Artificial drainage can usually be established without difficulty.

The entire area of this phase is utilized in some way. Some parts have not been drained or cultivated and remain in native grass land. The remainder is used for small orchards, truck, and small fruit patches, and flower gardens.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Holland coarse sandy loam, dark-colored phase:

Mechanical analyses of Holland coarse sandy loam, dark-colored phase.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
[illegible]	Soil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Subsoil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

OLYMPIC STONY LOAM.

The Olympic stony loam group includes all the soils in the area that are residual from the basic igneous rocks, which consist of andesite and basalt. Typically the soil is of brown to rather dark brown color, but decided variations occur, including patches of gray and red soils. In texture there is a wide range, the type including areas of loam, clay loam, sandy loam, and heavy clay adobe. Were the type of greater agricultural value it would be separated into several types and at least two series. Where strictly residual in origin the soil is underlain by parent bedrock at a depth of less than 2 feet. In small areas where colluvial or alluvial agencies are responsible for its formation or modification the soil is much deeper.

The type occurs along the northern and northwestern boundaries of the area, on Bald Mountain, and on occasional small hills within the valley. It occupies rounded hills, plateaus, and rough and irregular mountain lands. Only in a few small patches is the soil free from bowlders of andesite or basalt. The old auriferous gravels of an earlier period are scattered over parts of the type in the northwestern part of the area.

The elevation, rocky nature, and irregular topography have precluded development, except in very small areas where the land has been cleared and is farmed to grain. Around Susanville the soil supports a growth of pine, but in other parts of the area the vegetation is a scant growth of sagebrush and weeds.

JOHNSTONVILLE COARSE SAND.

The surface soil of the Johnstonville coarse sand consists of a brown to dark-brown, loose, coarse sand of micaceous, granitic character. The subsoil is similar to the soil in texture and dark grayish brown to lighter brown in color. While this type is classed with the Johnstonville series only the subsoil is of strictly lake-laid origin. The surface soil has been very decidedly modified by wind action and by deposition of material from intermittent drainage ways. The resulting material is in part gravelly. At varying depths below 2 feet the stratified, semicompacted deposits characteristic of the Johnstonville series occur. These range in texture from sands to silts and clay and may be locally cemented with iron or lime compounds. The subsoil may contain a sufficiently high percentage of fine material to class it as a sandy loam or the loose sand may continue to a depth of over 6 feet, in which case the soil is very leachy, not adapted to dry farming, and would require excessive quantities of water under irrigation.

The type occurs in small areas about Edgemont, in the Janesville-Milford district, and in a large area at Bird Flat School. The

topography ranges from gently sloping or nearly level to irregular or undulating, with steep terrace fronts. The areas are dissected by channels of intermittent streams. The elevation and the nature of the soil insure good drainage. Owing to the loose, open structure and the lack of water for irrigation, the type remains undeveloped and, except for a small acreage, is covered with sagebrush and rabbit bush. Attempts at dry farming have not met with much success, as the low retentiveness of the soil and the action of the wind both retard the growth of the crops. Grain is usually blown out before it can reach maturity. Stands of alfalfa which may be profitable have been obtained. Without irrigation but little of the type can be successfully developed.

Johnstonville coarse sand, loamy phase.—The surface soil of the loamy phase of the Johnstonville coarse sand is a brown to dark-brown, loose coarse sand. The type is characterized by sharp, angular quartz grains or granitic particles of the size of coarse sand, but there is mixed with these enough finer material to give some coherence and good water-holding capacity. The soil has a low organic-matter content and is in some cases drifted by wind. The subsoil is similar to the surface soil, or is of slightly lighter color, and is underlain by the various strata which compose the Lahontan Lake beds. Fine or cemented layers may occur at no greater depth than 2 or 3 feet from the surface, in which case they may be detrimental, acting as a hardpan. The soil, however, usually is deep enough for crop production, and in some places it is rather leachy, owing to the absence of a more impervious layer in the subsoil.

This phase occurs in one large body south of Ravl and in scattered areas in the Susan River Valley, the Lassen-Milford district, and Long Valley. The topography ranges from smooth and level to gently sloping or somewhat undulating where the surface has been modified by the recent deposition of sediments washed down from the Sierras. Small streams flowing through these areas have cut deep channels, and steep bluffs are numerous. The areas occurring along the base of the steep Sierras have been modified by excessive wash from the mountains, and separation from the Hanford series of soils is sometimes difficult. The bodies lying at some distance from the mountain foot slopes, as, for instance, the area about Johnstonville, have a more typical lake-terrace topography. Drainage usually is good. The subdrainage in a few instances is somewhat excessive, but the lower areas, such as those on the floor of Long Valley, may have somewhat restricted underdrainage.

Some areas of this phase, such as those in the valley of Gold Run, are forested with pine, with some small groves of oak. Most of the phase, however, supports a growth of sagebrush, rabbit bush, thistle

poppy, and a low, deciduous shrub (*Purshia tridentata*). The cultivated areas are devoted to alfalfa, both dry-farmed and irrigated, to dry-farmed grain, and to small home orchards and gardens. The alfalfa produces a thick, heavy stand when properly cared for and sufficiently watered. Much of the dry-farmed alfalfa is poorly handled and suffers at times for moisture, and the yields are consequently not large. Seed is produced successfully. The success of the grain crops depends largely on the amount and distribution of the rainfall. Usually the heads do not mature well and the yield, if threshed, would be small. It is customary to cut the crop for hay, only a small part being threshed. With the development of irrigation, this soil should prove productive and well adapted to alfalfa.

Below are given the results of mechanical analyses of samples of the typical soil and subsoil of the Johnstonville coarse sand:

Mechanical analyses of Johnstonville coarse sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
373121	Soil	8.4	24.0	18.3	33.0	7.4	5.3	3.7
373122	Subsoil	6.7	16.6	13.9	37.4	10.5	9.6	5.1

JOHNSTONVILLE SANDY LOAM.

The surface soil of the Johnstonville sandy loam is a brown to dark-brown, micaceous sandy loam to light sandy loam of friable structure. It grades into a lighter brown sandy subsoil, underlain at any depth from 2 to 6 feet or more by strata of fine and coarse material of brown to grayish color. These layers may be in part compacted or cemented, and so impenetrable as to act as a hardpan, although they seldom affect the character of the soil. Small quantities of fine to medium gravel commonly are present in the surface soil.

This type occurs in small areas between Lassen and Doyle and others near Constantia. Scattered areas occur in the northern part of the area. The surface is somewhat irregular and deep erosion channels occur, along the margins of which are sand dunes of considerable size. The drainage is good.

Little of the type is under cultivation, the greater part being covered with sagebrush, rabbit bush, and Purshia. A small part of the land is successfully dry farmed to alfalfa, yields of about 3 tons per acre being obtained. Dry farmed grain also does well, and a few small orchards produce fair yields, depending on the care they

receive. Where water is available for irrigation the yields can be materially increased.

Johnstonville sandy loam, poorly drained phase.—The Johnstonville sandy loam as mapped includes a dark-colored, poorly drained phase, which would be recognized as a distinct type if of greater extent. The surface soil of this phase is a dark brownish gray to black, micaceous sandy loam or coarse sandy loam. The organic-matter content is high and local bogs occur. In the typical soil, gravel is absent, but fine to coarse gravel occurs in small quantities in some areas. The subsoil consists of a dark brownish gray or black to brown sandy loam or loam which may continue to a depth of 6 feet or more, or the subsoil may be underlain at any depth from 1 foot to 6 feet by compacted or fine-textured lake-laid strata. As mapped, the phase includes patches of a heavier clay loam or fine sandy loam soil.

This phase occurs in small bodies along the terrace fronts or bluffs and as local depressions or poorly drained areas within the typical Johnstonville soil or at the base of alluvial fans of the Hanford series. The topography therefore ranges from steep bluffs to sloping or level plains. The phase usually owes its existence, in contrast with the typical Johnstonville soil, to poor drainage conditions. In a few cases drainage has recently been established by stream cutting or by artificial means, but the greater part of the phase remains wet. The excess water usually seeps from the compacted strata below and may drain from the surface, but in some cases the surface drainage is restricted. Springs, either intermittent or perennial, occur in many places.

Much of the land has not been developed and supports native grass and marsh growths, including a profusion of Equisetum. The grass lands are either pastured or cut for hay. In places where drainage is sufficient the phase is utilized for alfalfa, home orchards, and gardens. Alfalfa makes a dense, heavy stand, provided the field is given good care and the plants do not suffer from lack of water in the later summer months. The growth of a few apple and pear trees indicates the adaptability of the soil to these fruits, although most of the plantings have received little attention and suffer from the attacks of blight, moth, and other pests. The development of this land depends on the control of the water supply, involving removal of the excess moisture during the wet period of the year and the supplying of water during the summer months.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Johnstonville sandy loam and of the poorly drained phase of this type:

Mechanical analyses of Johnstonville sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
[illegible]	Soil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.7
[illegible]	Subsoil	[illegible]	[illegible]	21.0	25.4	[illegible]	15.6	[illegible]
Poorly drained phase:								
[illegible]	Soil	[illegible]	[illegible]	[illegible]	20.0	[illegible]	16.0	[illegible]
[illegible]	Subsoil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.0

STANDISH STONY SANDY LOAM.

The surface soil of the Standish stony sandy loam is a brown to dark-brown sandy loam, in places of rather heavy texture, approaching a loam. It contains varying quantities of fragments of basic igneous rocks, ranging in size from small gravel to large bowlders. The subsoil typically is similar to the surface soil, but may be somewhat lighter in color and texture, as in most of the areas lying along the base of the Sierra Nevada. A shallow variation of this type occurs in those areas lying about Bald Mountain, where bedrock of andesite or layers of old cemented, fragmental deposits occur within the 6-foot soil section. The large body of the type northeast of Litchfield includes both the typical soil and the shallow variation.

The Standish stony sandy loam occupies old, high terraces adjoining higher rocky formations and old high bars and débris aprons which can not be satisfactorily separated from the terraces. The elevation of the type insures good drainage, but makes irrigation impracticable. The soil is at present entirely uncultivated and remains in sagebrush and other low-growing plants. Local areas may prove well suited to fruits, provided water for irrigation could be obtained.

The following table gives the results of a mechanical analysis of a fine-earth sample of soil of the Standish stony sandy loam:

Mechanical analysis of Standish stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
[illegible]	Soil	12.0	[illegible]	[illegible]	24.0	17.6	[illegible]	7.4

STANDISH GRAVELLY SANDY LOAM.

The Standish gravelly sandy loam consists of a loose, dark-brown or dark grayish brown light sandy loam to sandy loam, carrying

fine and medium gravel in considerable quantities, resting on a subsoil of similar or somewhat lighter color and texture. Stratified lake deposits of variable texture and structure may or may not occur within the 6-foot section (see Pl. I, fig. 3).

This soil occurs in small scattered areas north of Bald Mountain in the vicinity of Sunnyside, west of Standish, in a large body southeast of Bird Flat School, and in an area east of Constantia. The type comprises parts of lake-laid bars or spits. These are elevated above the surrounding country and both surface drainage and subdrainage are good to excessive.

Owing to the elevation of the areas irrigation is not at present practicable and the type is mainly undeveloped. A small part is dry farmed to grain, with low yields. The greater part is covered with sagebrush. It is probable that some of the land will soon be brought under irrigation, but the higher lying areas apparently will not be improved in the near future. With irrigation the type should give good crops of alfalfa.

The two areas of this type occurring at Sunnyside represent old lake terraces which have been highly modified by alluvial-fan deposits, the resulting soil being a rich, brown sandy loam containing varying quantities of medium to fine gravel, consisting mainly of basalt. The soil and subsoil may be uniform to a depth of 6 feet or more or the material may grade at less depths, possibly only about 6 inches below the surface, into stratified lake-bed deposits of light or medium texture. The drainage is good, and fruit trees, especially apples and cherries, in small orchards produce abundant crops with very little care. Owing to the small extent of this soil and to the fact that the greater part is included in the town of Sunnyside, it is not used for commercial orcharding.

The following table gives the results of a mechanical analysis of a fine-earth sample of soil of the Standish gravelly sandy loam:

Mechanical analysis of Standish gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
[illegible]	Soil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STANDISH SAND.

The Standish sand consists of a brown sand, rather fine in texture, which continues without distinct change to a depth of 6 feet or is underlain at depths of 3 to 4 feet by a sandy loam or heavier textured material of the same or somewhat lighter brown color. This ma-

terial is underlain at variable depths by stratified lake-laid sediments, frequently compact or semicemented. The deeper subsoil and the substratum are generally calcareous. The soil is friable and loose in structure, and some areas have been drifted into dunes. Small quantities of fine gravel may be present in the surface soil. Evidences of the former action of hot springs are numerous and nodular deposits or small concretions of calcareous tufa occur, especially south of Standish, where the type approaches in character the Churchill sandy loam.

The largest area of this type extends between Standish and Edgemont. Other bodies occur between Standish and Leavitt Lake. The type is everywhere well drained. The higher lying areas have a somewhat uneven topography.

Much of the type lies above present irrigation ditches. Where it is irrigated good yields of alfalfa are obtained, some fields having yielded heavily for many years. Grain produces fair yields in some of the unirrigated areas. Much of the type is covered with sagebrush and rabbit bush. Further development will depend on irrigation.

STANDISH SANDY LOAM.

The surface soil of the Standish sandy loam is a friable, medium to fine textured sandy loam, ranging from rich brown to dull brown in color. Below the depth of 18 inches there occur in places strata of heavy loam or clay loam which may be compact. This material may continue to a depth of 6 feet or more or may be displaced by sand, sandy loam or fine sandy loam. The subsoil is of slightly lighter brown to yellowish-gray color and usually is well supplied with lime. The type in places is somewhat lighter textured and some bodies of sand may be included.

The type occurs chiefly about Standish and in one large area in Long Valley. Smaller bodies are encountered in other parts of the area. It occupies gently sloping to level mesa lands as well as level areas which extend well down to the floor of the valley. In the former case the surface drainage and subdrainage are good; in the latter both may be restricted and the agricultural value of the soil may be impaired by a high water table and the presence of alkali. In the higher areas the native vegetation includes sagebrush and rabbit bush, but where the drainage is poor and there is an accumulation of alkali a growth of greasewood and salt grass occurs (see Pl. II, fig. 1).

If well drained the type is adapted to alfalfa under irrigation, and about Standish it is used for this crop. Some fields have been cropped continuously for 20 years and still give excellent returns,

yielding as much as 5 tons to the acre. The greater part of the type is, however, undeveloped, owing largely to a lack of water. A part is dry farmed to grain, with varying results, depending largely on the methods of cultivation, seeding, and general care. Grain is grown in places under irrigation.

Those areas containing much alkali are not worth the expense of reclamation and development under present conditions. Intensive utilization of the remainder of the type depends on the possibilities of obtaining an adequate supply of water for irrigation.

STANDISH LOAM.

The surface soil of the Standish loam is a brown to dark-brown loam which in some areas contains a small quantity of fine and medium gravel and may include material of lighter fine sandy loam texture. The soil may be friable or may be somewhat plastic and have a tendency to puddle, owing in part to the presence of black alkali. The subsoil is usually of lighter brown color. At any depth from 1 foot to 6 feet or more the soil is underlain by a variety of calcareous stratified materials of light or heavy texture, which represent Lake Lahontan deposits. These may be compacted or semicemented so as to interfere with the drainage and the penetration of plant roots. On the other hand, the subsoil may be friable, in which case the structure of the type is suitable for growing alfalfa and other deep-rooted crops.

The Standish loam occurs in small bodies scattered through the area, especially in the Susan River Valley, about Standish and Stacy, and in Long Valley. Its total area is small. Surface drainage is generally fair to good, but subdrainage is in places restricted. In those bodies occupying the north slopes of the valley erosion is severe in a number of places. In some places alkali is present. In alkali areas the vegetation is limited to greasewood and salt grass; in the better drained areas sagebrush grows profusely. Very little of the type is under cultivation. In the area at Susanville truck crops are grown. Small areas are dry farmed to grain, which gives low yields. Some alfalfa is grown under irrigation, with satisfactory results. Much of the type lies too high for irrigation under present systems or beyond the limits of ditches. In areas in which the subsoil is not too refractory and where irrigation can be practiced the soil is well suited to alfalfa and truck crops. Where the subdrainage is imperfect the accumulation of alkali salts is an important factor in retarding the development of this type.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Standish loam.

Mechanical analyses of Standish loam

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
[illegible]	Soil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Subsoil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STANDISH CLAY LOAM.

The surface soil of the Standish clay loam is a dark brown to dark grayish brown clay loam. At a depth of about 12 inches the surface soil grades into a light-brown to light yellowish brown or light brownish gray subsoil, variable in texture and calcareous. Usually this is a heavy clay loam or clay, but strata of sandy loam or loam may occur within the heavier material.

Small depressions occupied by silty clay loam, clay or sandy clay soil are scattered through the lower lying areas of the type, the sandy clay being most prominent. These areas consist of a brown clay of rather compact structure, carrying a sufficiently high percentage of sand to give a gritty feel. The subsoil at a depth of 1 to 2 feet becomes lighter in color and usually grades into strata of sandy loam or fine sandy loam, or it may continue as a sandy clay or clay. The underlying material is calcareous and may have a light-gray or yellowish tint.

The soil material in places is somewhat too dark in color to be typical of the Standish series, sometimes being dark gray with but a slight brownish tint. In color these areas approach the Carson series, but in topography and drainage they are more closely associated with the Standish series.

The Standish clay loam occurs in the vicinity of Leavitt Lake, on the Standish Mesa, and in scattered small bodies throughout the northern part of the area. The surface is smooth and level to gently undulating. Surface drainage ranges from good to very poor. The subdrainage is restricted, and alkali occurs in the lower areas. Where the drainage is good and water is available for irrigation the soil produces excellent stands of alfalfa. The more poorly drained areas are in grass, and where badly affected with alkali or where unirrigable are not utilized.

LAHONTAN SAND.

The soil of the Lahontan sand is a light-gray sand, high in lime and low in organic matter. To a depth of 3 feet or more the material is friable and loose. Beneath this it consists of layers of sand and finer sediments extending to undetermined depths. The finer

textured of these strata may be somewhat compact and may restrict subdrainage, but the type is without true hardpan.

The Lahontan sand occurs in two small areas, one on Honey Island and the other on the southeast shore of Honey Lake. The topography is level to slightly irregular. Wind action is undoubtedly responsible, in part, for the position and surface condition of this soil. The type can not be sharply separated from the Preston sand, from which it differs generally in the nature of the subsoil, in topography, and for the greater part in color and content of organic matter.

The type is very poorly drained, and its low position renders artificial drainage difficult or impossible. Alkali normally is present in considerable quantities.

Alfalfa may be successfully grown in places on the higher areas, but at present the type is used only for a few small fields of grain. The uncultivated areas support a stunted growth of sagebrush, greasewood or salt grass.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Lahontan sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
573115.	Soil.	2.0	11.8	17.0	47.6	8.0	7.7	5.9
573116.	Subsoil.	1.0	12.4	14.2	41.2	8.4	8.7	14.1

LAHONTAN FINE SANDY LOAM.

The surface soil and subsoil of the Lahontan fine sandy loam are of light-gray to light brownish gray color. The texture of the surface soil averages a fine sandy loam but is not uniform, quite extensive areas of sandy loam and small areas of fine sand being included. The action of wind is in a large part responsible for this variation. The soil is friable and of high lime content but deficient in organic matter.

The subsoil is variable. It may be fine sandy loam to a depth of 6 feet, or heavier subsoil materials may occur. Stratified deposits of widely varying texture often occur in the lower part of the 6-foot section. Hardpan is absent, though layers of calcareous tufa sometimes occur, and in places affect the soil to some extent. Where these layers are of sufficient thickness to affect the agricultural value the area is mapped as a member of the Churchill series. The greater

FIG. 1.—TERRACE OCCUPIED BY SOILS OF THE JOHNSTONVILLE SERIES IN FOREGROUND.

Recent lake bottom occupied by soils of Carson series in distance on left. Honey Lake in distance on right.

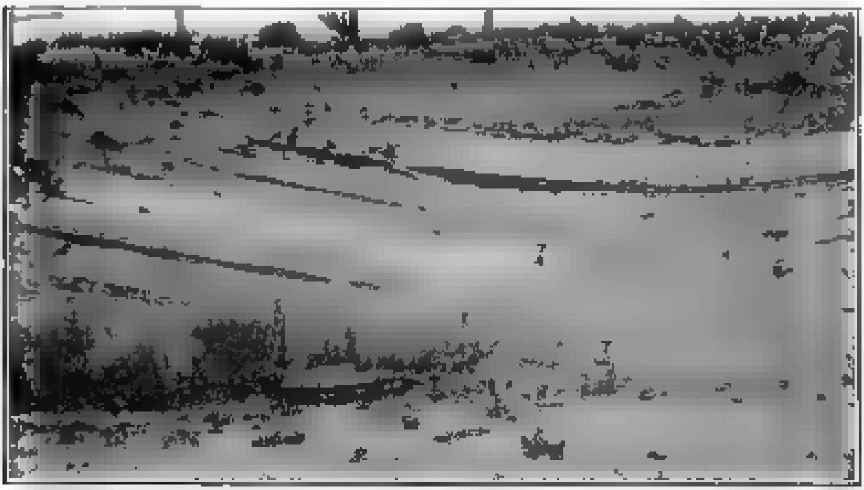

FIG. 2.—EXPOSURE OF STRATIFIED SEDIMENTS OF THE LAHONTAN LAKE BEDS UNDERLYING THE STANDISH GRAVELLY SANDY LOAM, NEAR SUSANVILLE.

FIG. —STANDISH SANDY LOAM NEAR LITCHFIELD, SHOWING TOPOGRAPHY AND NATIVE GROWTH OF SAGEBRUSH.

FIG. 2.—LAHONTAN LOAM SOUTHEAST OF AMADEE.

In the distance Hot Springs Mountains, mapped Olympic stony loam. Small alluvial fans at their foot occupied by soils of the Stacy series.

part of the type is either affected with alkali at present or is subject to the accumulation of alkali under irrigation.

The largest body of the Lahontan fine sandy loam occurs on and south of Honey Island. Other scattered bodies occur on the island, and north and east of Honey Lake. The drainage of the type ranges from good to very poor. The large body south of Honey Island has a high water table, and the soil contains much alkali. Other areas are free from alkali, spotted with alkali or uniformly affected, depending upon the drainage condition. The better drained areas are farmed, and owing to the friable, calcareous nature of the soil are very productive. On parts of the type drainage can not be readily established. The native vegetation includes saltbush, salt grass, greasewood, and sagebrush.

LAHONTAN LOAM.

The surface soil of the Lahontan loam is typically a light-gray loam, but over much of the type as mapped it has a relatively high content of silt and there are probably some areas of silt loam included. The soil is high in lime and low in organic matter. Near contact with the Lahontan silty clay loam the type becomes very silty, and with approach to sandy types it is decidedly sandy. The soil is friable and where well drained is highly desirable for alfalfa. The subsoil is variable in texture, consisting of sandy loam, fine sandy loam, silt loam, sand or interbedded layers of light and heavy textured materials. Usually it is friable and open, but over small areas compact or cemented, and of the nature of a true hardpan. In color it is light gray or brownish gray, usually becoming light gray on continued exposure. The subsoil is highly calcareous.

The type occurs south of Italy and northwest of Canova, and there are other areas on and south of Honey Island. Several bodies occur north and northeast of Honey Lake, the larger extending from Amedee to and beyond Wendel. The topography is level or slightly uneven. Small, low dunes of sand occur in places. The surface drainage and subdrainage range from good to very poor. The alkali content is so high in the more poorly drained areas as to preclude agriculture. The better drained and alkali-free areas are well adapted to alfalfa with irrigation. Small areas are dry farmed to grain. At present, the greater part of the type is covered with sagebrush, greasewood, saltbush, and salt grass, the first occurring in the better drained situations (see Pl. II, fig. 2).

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Lahontan loam:

Mechanical analyses of Lahontan loam.

Number	Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
[illegible]	Soil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Subsoil	[illegible]	[illegible]	1.9	[illegible]	[illegible]	[illegible]	[illegible]

LAHONTAN SILTY CLAY LOAM.

The surface soil of the Lahontan silty clay loam is light or ashy gray in color, grading into a rather yellowish or yellowish-brown subsoil at a depth of 1 to 3 feet. The subsoil changes sharply to a loose sand within the 6-foot section over a part of the type, but material of the same texture as the surface soil may continue to great depths. The depth at which the sand occurs has an important bearing on the agricultural value of the soil, those areas in which the silty soil is continuous having poor subdrainage and being affected with alkali. The subsoil material where exposed has the ashy-gray color of the soil.

In texture the soil is variable, ranging to a clay loam or light clay. Owing to the lack of organic matter and the fine texture of much of the material the soil is sticky and is inclined to puddle. This tendency is accentuated by the occurrence of black alkali in varying quantities.

Local variations in the character of the material occur. In the vicinity of the Skedaddle Creek fan the type over several square miles has been more or less modified by sediments deposited in thin layers over the surface by the flood waters of the creek. In patches weathering has proceeded to an extent sufficient to give the soil a reddish color. Small dunes occur infrequently.

By far the greater part of the East Side and the Island sections of the area is occupied by the Lahontan silty clay loam, as are also considerable areas along the margin of the Susan River Valley. Typically the soil is level or very gently sloping. In small areas, such as those adjoining Leavitt Lake, it has a terrace topography. About Calneva the type occupies the bottom of a basin which, owing to the low rainfall, is never filled, but which with the introduction of irrigation would be covered by an extensive playa lake. The very poor drainage conditions, together with the high alkali content of the subsoil, make much of the type worthless for intensive agriculture. Where drainage is naturally good or can be established the soil is valuable for sugar beets or other root crops. The type is especially suited to alfalfa because of its high lime content. In-

ever, to get a good stand. Sweet clover or a winter crop of rye may be used to precede alfalfa. The native vegetation is sparse. Sagebrush grows over the better drained areas of the type, but the greater part is covered with spiny saltbush and greasewood.

At present this type is not utilized to any considerable extent, and it occurs as vast desert plains covered only with a low growth of greasewood, saltbush or sagebrush and containing numerous barren playas. Many proposals have been made to develop this soil on a large scale by irrigation projects, which were never completed. Development of the type depends upon the introduction of water and the establishing of subdrainage. Some areas are not susceptible of development because of the presence of alkali and the difficulty of drainage.

LAHONTAN CLAY.

The Lahontan clay consists of a light-gray, highly calcareous clay, resting on a subsoil of very heavy yellowish clay, which grades abruptly generally between the depth of 4 and 5 feet, into gray, loose sand.

The larger of the barren playas occurring within the Lahontan silty clay loam, namely, the playas north and south of Calneva and one small playa on the Island, are occupied by this type. These areas are barren of vegetation and are locally known as "slick spots." During wet winters they are covered with water, and exist as very shallow lakes. During the summer they appear as white, barren spots on the surface of the plains.

All this type is affected by the accumulation of alkali. The content of soluble salts may be extremely high. The impossibility of drainage and the present high salt content of this type prevent its agricultural development.

Lahontan clay, dark-colored phase.—The Lahontan clay, dark-colored phase, is confined to a depression in the Lahontan plain near Calneva known as Duck Lake, which during ordinary dry years acts as the sink of Skedaddle Creek. In wet years the lake overflows and the waters of the creek spread over a number of barren playas. The waters of Skedaddle Creek have deposited fine sediments in the lake bottom. The surface material is properly Stacy material, but the subsoil is true Lahontan. The soil material is derived mainly from andesite.

The surface soil of the phase is drab to brown or chocolate brown in color. A conspicuous feature of the soil is its structure. The material on drying checks into fine fragments forming small pellets, or "buckshot." It is this property which has resulted in the formation of the adjoining clay dunes, mapped as the Preston clay adobe. The

subsoil and substratum material is somewhat lighter in texture than the surface soil and is of the light color typical of the Lahontan subsoils in general.

In very dry years no water reaches the lake from Skedaddle Creek. During wet years, water remains in small pools in the lowest depressions throughout the summer, favoring the growth of marsh grasses, which are cut or pastured. The hay is coarse and of low value. The position of this soil makes its drainage and improvement impracticable, and it is best adapted to its present use.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Lahontan clay and of the dark-colored phase:

Mechanical analyses of Lahontan clay

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
673107	Soil	0.1	0.2	0.2	1.4	4.0	30.4	63.6
673108	Subsoil	.1	0	1.3	0.2	31.5	46.2	20.6
Dark-colored phase:								
673161	Soil	1.1	3.1	.8	3.6	5.6	20.7	66.2
673162	Subsoil	5.0	18.5	18.9	24.9	6.4	4.6	18.4

TUSCAN GRAVELLY LOAM.

The soil of the Tuscan gravelly loam varies greatly in texture and in color. The loam texture probably predominates. The color may be brown, grayish brown or reddish brown, and in a few cases is red. Gravel particles of varied origin occur, including old auriferous gravels and those derived from later andesites and basalts. The substratum consists of a wide variety of material, including andesite bedrock, volcanic tufa, and stratified lake sediments more or less cemented. The subsoil and substratum are usually so impenetrable as to make the type of little or no value for agriculture. Occasional small bodies may be capable of some agricultural development.

The type is the result of the weathering of old valley filling or lake-laid material which must have been laid down at a very early period. The material was composed entirely or in part of mud flows accompanying volcanic activity and of lake-laid deposits of the Lahontan period, which either consisted originally of shallow layers over a volcanic deposit or have since been reduced to a shallow layer through erosion. The type occurs in scattered bodies about the margin of the Susan River Valley, generally lying above present irri-

gation developments. The topography is gently sloping to steep or irregular and the soil is subject to erosion.

The Tuscan gravelly loam is used for grazing, but only to a small extent.

CHURCHILL STONY LOAM.

The soil material of the Churchill stony loam is a lacustrine deposit, being either a shallow layer of sediment deposited upon the rocks skirting the margin of the lake or the remnants of a deep terrace which has been almost entirely washed away.

The type occurs in two variations. One is found within areas of soils of the Lahontan and Standish series, where the continued action of hot springs has left massive nodular deposits of calcareous tufa. The second occurs along the base of the lava beds and cones which skirt the valley to the north. It is evident that throughout the entire length of these hills skirting Honey Lake Valley hot springs were at one time numerous and active and deposited immense quantities of calcareous tufa. The soil here is very shallow and is underlain both by masses of tufa and by basalt and andesite at a depth of a few inches. Fragments of the lava rock and large masses of tufa cover the surface.

This type is entirely in a virgin state, supporting a growth mainly of stunted sagebrush, with some saltbush. It possesses little value, owing to its position in most cases above irrigation and to its rocky nature and shallow depth.

CHURCHILL SANDY LOAM.

The Churchill sandy loam consists of a friable sandy loam of light-gray to brownish-gray or brown color. The soil material corresponds to that of the Lahontan and Standish series, but has been modified by layers or masses of calcareous tufa in the subsoil. These calcareous deposits in places are of such hardness or thickness as to act as a hardpan. Elsewhere they are decidedly fragmentary, and in still other places so thin that their harmful effects may readily be counteracted by subsoiling. Over parts of the type they render the soil almost valueless agriculturally. In one small area south of Standish the calcareous deposits are so deeply buried or so fragmentary as to have little effect on the soil.

The greater part of the type occurs north of Stacy. Injurious accumulations of alkali are unusual. With the exception of the body south of Standish, which has recently been planted to grain, this type is not used for agriculture. It is covered with greasewood, saltbush or sagebrush.

CHURCHILL LOAM.

The soil of the Churchill loam is light gray in color, highly calcareous, and low in organic matter. The material consists of lake-laid materials identical with those of the Lahontan series. The texture ranges from a light loam to a heavy loam, containing a relatively large percentage of silt. Within 3 feet of the surface, however, the soil usually is underlain by layers or masses of calcareous tufa which affect the agricultural value of the land. Small fragments of this material are also scattered over the surface of the soil, and occasional "mushrooms" or irregular deposits ranging up to several feet in diameter occur.

A small body of this type occurs at Amedee where several hot springs are active at the present time. Larger areas lie north of Stacy and one area on Honey Island. In places where the tufa of the subsoil is fragmentary or not too thick to be fractured by blasting or by subsoiling the type may be brought under cultivation and used for growing alfalfa or other crops with irrigation. Accumulations of alkali occur in places. The limited supply of water for irrigation and the elevation of much of the type, combined with the unfavorable nature of the subsoil, make farming in general impracticable. The soil supports only a stunted growth of sagebrush, spiny saltbush, and salt grass.

CARSON LOAM.

The surface soil of the Carson loam is a dark-gray to black loam which in places approaches a fine sandy loam in texture. The soil is rich in organic matter and lime, and is friable to slightly compact in structure. The subsoil is somewhat lighter in color than the surface soil. It may be distinctly brownish, and is highly calcareous. In texture it is heavier than the surface soil, ranging from a heavy loam to clay. In local areas, especially in the bodies of the type southeast of Standish, the soil is more shallow than typical, materials corresponding to the Lahontan Lake beds occurring within the 6-foot column. This material may be so compact as to form a hardpan, lowering the value of the soil for agriculture. Where the hardpan occurs conditions favor the accumulation of alkali, and these areas frequently support saline vegetation.

The type occurs in several areas on the Susan River delta and along the northwestern and western borders of Honey Lake. Much of the land is poorly drained and is subject to overflows. The better drained areas are in alfalfa, which gives light, medium or heavy yields, depending on the degree of drainage. The remainder of the type is grassland or pasture, with flats of greasewood and salt grass. Where drainage can be established the soil is very productive, but

the low position prevents satisfactory drainage over a large part of the type.

In the area north of Standish the soil varies from the typical in that it is derived from an older formation, somewhat similar to the Lahontan deposits. Continued saturation and slight recent alluvial deposits of soil over the older material, however, make the area, from an agricultural standpoint, more closely related to the Carson series. The soil here is decidedly saline and of little value. It is covered with greasewood and stunted sagebrush.

CARSON CLAY LOAM.

The surface soil of the Carson clay loam is a dark-gray to black clay loam, grading into a subsoil of the same or somewhat lighter color, extending to a depth of 6 feet or more. Typically, the subsoil is a heavy clay of adobe structure, and in low depressions the surface soil has a similar structure, giving rise to the Carson clay adobe type. Over part of the type, however, the subsoil is similar to the typical surface soil, although occasionally lighter textured material occurs within the 6-foot section. Both surface soil and subsoil are high in organic matter.

Small areas of Peat and Muck occur within the type as mapped, including parts of the low, swampy areas indicated upon the soil map by swamp symbols. Especially is this true of the extreme lower part of the delta, where the soil might well be classed as Muck, and of bodies occurring in the drainage ways of hot springs. Both surface soil and subsoil here are high in lime. The soil is undoubtedly very fertile and would be highly productive were it not for the prevailing poor drainage conditions.

The clay loam is the most extensive type of the Carson series. It covers the greater part of the Susan River delta and occurs in scattered bodies about Honey Lake and in the Susan River valley. It is on this type that the production of hay and pasturage, with very wasteful methods of irrigation, has reached its largest development. Plate III, figure 1, shows cattle grazing on soils of the Carson series northeast of Honey Lake.

Drainage is poor throughout the type, much of the land being overflowed for several months every year, and on account of the low position there is but little possibility of artificial drainage. In the area on the Susan River delta, though the present salt content is not sufficient to warrant mapping the type as alkali land, concentrations frequently occur in the subsoil. The other areas are in part affected with alkali. In most cases alkali is a controlling factor in the agricultural development of the type. Reclamation of the affected areas is difficult or impracticable.

Alfalfa is grown successfully in small fields on the better drained areas of this type. Some grain also is grown, giving only low yields. By far the greater part of the type supports a growth of coarse grasses.

CARSON CLAY ADOBE.

The surface soil of the Carson clay adobe is a very sticky, black clay, high in lime and organic matter and having a pronounced adobe structure. The subsoil may be of similar character to a depth of 6 feet or more, or may be underlain below a depth of about 36 inches by a clay loam or material of slightly lighter texture. The subsoil also contains much lime and organic matter and is black in color, occasionally mottled with brown in the lower part.

This type occurs in small bodies in the delta region and in larger areas in the Susan River valley north of Leavitt Lake. It is poorly drained and is in large part overflowed in the wet season. On the better drained areas alfalfa is grown in small fields, but the greater part of the type is in grass. The present grass lands are of poor quality and should be improved.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Carson clay adobe:

Mechanical analyses of Carson clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
37125	Soil	0.6	1.7	1.2	5.4	5.0	51.1	35.4
37126	Subsoil	.9	3.9	2.4	11.9	5.8	34.9	40.0

BUNTINGVILLE SANDY LOAM.

The surface soil of the Buntingville sandy loam is typically a brown to dark-brown or dark grayish brown sandy loam, but it varies widely in color in small areas, patches of black soil occurring through the brown areas wherever slight depressions or especially poorly drained spots occur. The texture also varies to some extent, some areas being a very light sandy loam. The subsoil may be either lighter or heavier in texture than the surface soil, but it is usually of similar color. In the lower lying areas heavy-textured material may approach the surface, and in the lower part of the 6-foot section the material may be a heavy clay loam or clay. On the other hand, the subsoil is sometimes a loose sand. Alternating layers of fine and coarse material also occur.

FIG. 1.—CATTLE GRAZING ON SOILS OF CARSON SERIES, NORTHEAST OF HONEY LAKE.

FIG. 2.—HANFORD STONY SANDY LOAM ON ALLUVIAL FAN AT FOOT OF SIERRA NEVADA MOUNTAINS.

Farm in middle distance partly ruined by deposit of material taking place at time of recent cloudburst and freshet. Soils of the Lahontan series on valley floor in distance.

Areas of this type lie in the Susan River Valley and skirt the lake to the north and west. Its low position prevents drainage, and most of the type is water-logged and affected with alkali. The surface is somewhat uneven, and leveling would increase the productiveness of some fields.

The type is used to some extent for alfalfa and grain production and in part supports grasses of rather poor quality, used for pasturage and hay. Alfalfa gives only fair returns. The yields of grain vary, depending mainly on the alkali content of the soil. Where drainage is possible the type is adapted to alfalfa. It may be used for growing truck crops. The lower areas, containing accumulations of alkali, remain in greasewood and salt grass, and their reclamation is not warranted under present conditions.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Buntingville sandy loam.

Mechanical analyses of Buntingville sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
573356.	Soil.	14.0	31.6	6.1	17.0	8.5	22.1	0.9
573357.	Subsoil.	21.4	37.4	3.9	17.2	5.4	8.2	4.1

BUNTINGVILLE LOAM.

The Buntingville loam is a dark grayish brown loam, resting on a subsoil lighter or heavier than the soil, of the same color as the soil or darker, and mottled or variegated. In some areas it grades into a light sandy loam at from 2 to 6 feet, and in others the subsoil is throughout a heavy clay loam. Both soil and subsoil are friable.

In small areas the organic-matter content is very high, but the greater part of the type has a somewhat lower content than would be expected of a soil of this general nature. The surface soil and subsoil are well supplied with lime, but the lime content is lower than in the associated Carson series. As mapped small areas of fine sandy loam and silt loam are included with the loam.

A shallow variation of this soil occurs in which a substratum of the older lake beds is encountered within the 6-foot soil section. Where this condition exists there has been some accumulation of alkali, although most of the type contains no alkali.

The greater part of this soil occurs in two areas southeast of Susanville. Others areas are encountered between Susanville and Lassen and in the bottom of Long Valley. In all cases the position of the type is such that drainage is poor, and much of the land is subject to overflow or to a high water table during the wet months.

Owing to its poorly drained nature, the Buntingville loam is kept in grasses, except for a small acreage of alfalfa. The grass land usually is poorly cared for and should be improved. The alfalfa fields are crudely flooded and produce only medium or low yields. Leveling of the fields and a more careful regulation of the use of water are needed. Much of the type is best adapted to grass. The native vegetation consists mainly of various grasses and Equisetum.

The following table gives the results of a mechanical analysis of a sample of soil of the Buntingville loam:

Mechanical analysis of Buntingville loam.

Number	Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
[illegible]	Soil........	1	4.6	3.0	13.8	18.9	42.2	16.2

BUNTINGVILLE CLAY LOAM.

The surface soil of the Buntingville clay loam is dark grayish brown or drab in color, becoming very dark or almost black when wet. The subsoil sometimes lacks the brown tint of the surface soil and ranges from gray to dark gray or black. The surface soil is a silty clay loam or clay loam with small undifferentiated bodies of clay in local depressions. The subsoil is of the same texture as the surface soil, or may vary slightly in the lower part. A few small areas are underlain by a deeper, light sandy subsoil.

In common with most of the other recent-lacustrine types, areas occur in which a substratum of the older lake sediments is encountered within 6 feet of the surface. The older sediments are more impervious to water than the recent materials and tend to restrict the subdrainage, resulting in a tendency toward the accumulation of alkali. Along Piute Creek small areas of this type have the topographic position of a river flood-plain soil.

The Buntingville clay loam is the most extensive type of the series. It occurs mainly in a large area in the Susan River bottoms east of Susanville and in Long Valley. Scattered small areas are mapped between Susanville and Lassen.

The soil has poor to moderately good drainage. Large areas are subject to overflows during the wet months. This condition has tended to retard development, and where the subdrainage is poor the accumulation of alkali at the surface has rendered the land of very little value. On the other hand the presence of moisture has resulted in a good though not large content of organic matter. Lime is present in sufficient quantities to counteract acidity.

The greatest opportunity for developing this type lies in the improvement of the grass lands. Some alfalfa is grown, but the yields are low. A more careful use of water and more care in leveling fields would improve the stands of this crop. A few fruit trees have been set out on the type, with only fair results. Potatoes are grown in small patches, and good yields are reported.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Buntingville clay loam:

Mechanical analyses of Buntingville clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
27158	Soil	0.2	1.4	3.6	12.6	11.5	47.1	23.2
27159	Subsoil	.1	1.8	2.1	27.0	14.8	37.8	[illegible]

HANFORD STONY SANDY LOAM.

The Hanford stony sandy loam consists of a brown sandy loam or sand containing coarse quartz fragments and large and small bowlders and gravel of granodiorite or similar granitic rocks in such quantities as to affect the type agriculturally. This material may be uniform in texture and structure to a depth of 6 feet or more, or the rock fragments may occur chiefly at the surface, the soil changing with depth to a gravelly sand or sandy loam subsoil.

This type is derived from alluvial-fan deposits and includes land which is of agricultural value, though stony, as well as land that is little more than a débris apron of coarse to massive rock fragments. The fans are shallow at the margin and are underlain by the materials of the adjoining types.

The Hanford stony sandy loam occurs as moderately to steeply sloping areas along the footslopes of the Sierra Nevada (see Pl. III, fig. 2). It is irregular and broken in topography and in many places is subject to severe erosion. These unfavorable features and the elevation of the type above present irrigation supply have prohibited its development and the land now supports a growth of sagebrush and chaparral or of small trees or it is barren. The feasibility of irrigating most of the type is doubtful, even if water were available. Where the topography is favorable the heavier textured areas may be adapted to the production of fruits and in small areas to alfalfa.

A very distinct variation of this type occurs at Lassen. The origin of the soil here is somewhat uncertain, but it is evidently, in part at least, the result of an immense landslip which brought

down a great mass of material, including, besides the granodiorite, large quantities of basalt. Wells in the vicinity of Lassen indicate that this débris is at least 30 feet deep south of the town and probably it is of great depth in the higher areas to the west. The greater part of the rock in some parts of this soil body is basalt, but the finer soil material is derived from granodiorite, and this rock is present in places. In the northern part of this body the soil is largely free from rock fragments and includes areas well adapted to fruit growing. Other areas occurring in the same vicinity carry more or less basalt and andesite rock, brought down from Thompson Peak and the crests of adjoining mountains. The soil, however, is almost entirely derived from granodiorite. Basic igneous rocks do not occur in the areas of the type mapped farther to the south.

HANFORD GRAVELLY SANDY LOAM.

In color and general character the Hanford gravelly sandy loam is like the Hanford sandy loam, differing from it only in having a larger content of gravel, consisting of fragments of diorite and of basic igneous rock. The latter, however, is not very conspicuous in the soil material, which is derived mainly from granodiorite.

This type occurs as small scattered areas representing alluvial fans along the base of the Sierra Nevada.

HANFORD COARSE SAND.

The Hanford coarse sand consists of a brown to grayish-brown, micaceous coarse sand, largely quartz. It is loose and leachy in structure. The subsoil below the depth of 24 inches may be heavier than the surface soil, giving the type a good water-holding capacity. In no case is the subsoil heavier than a sandy loam. Usually the sand or coarse light sandy loam extends to a depth of 6 feet or more. Gravel may occur in the subsoil. While the soil is coarse and loose, it supports a sturdy growth of sagebrush. The organic-matter content is moderate.

One small body of this type occurs west of Bird Flat School. The greater part occurs south of Calneva along the northeastern slope of the Fort Sage Mountains and in Long Valley. The type occupies steeply sloping alluvial fans, which are subject to continuous modification by wind and by the flood waters from the small canyons above.

As no water for irrigation is available, no development of the type has taken place, and it is either covered with sagebrush or has been cleared and affords sparse pasturage. If irrigation water could be supplied, the soil would be adapted, where the topography or erosion is not prohibitive, to the production of stone fruits and alfalfa.

HANFORD SANDY LOAM.

The Hanford sandy loam consists of a friable, loose, light to medium sandy loam, of brown color and typically 6 feet or more deep. As is characteristic of alluvial fan soils, however, the soil at the margins of the areas is shallow and is underlain by the material of the adjoining types. Fine to medium gravel is present in small quantities in the subsoil, and occasionally small areas of gravelly or stony soil occur. There are also included small areas of coarse sandy loam and coarse sand. Mica is present, but not in conspicuous quantities.

The type occurs on alluvial fans at the base of the Sierra Nevada, especially in Long Valley and at the base of the Fort Sage Mountains. These fans are gently to steeply sloping, the greater part of the land being suitable for farming. The slope, texture, and structure of the soil insure good drainage. In the higher areas the air drainage is good, but the lower parts of the fans are but little better situated in regard to frost protection than the floor of the valley. The native vegetation consists mainly of sagebrush, which grows luxuriantly.

At present the Hanford sandy loam is mainly unused, although some areas have been cleared and are devoted to alfalfa and pastures. Dry-farmed alfalfa in a few cases produces fair yields. Where water is available for irrigation the crop grows very luxuriantly, the stools being heavy and closely set. A few fruit trees and small home gardens give good returns with proper care.

FOSTER SANDY LOAM.

The Foster sandy loam is a dark-brown or dark grayish brown micaceous loamy sand to a heavy sandy loam, the sandy loam predominating. Typically the subsoil is similar to the surface soil, the material continuing to a depth of 6 feet or more practically without change, except for a slightly lighter color. The strips in which the type occurs, however, include material which differs somewhat from the typical, representing the shallow portion of stream flood plain deposits about the margins. The subsoil here is usually heavier and of lighter color and is similar to the adjoining lake-laid deposits. Besides this variation there are differences in color and texture of the surface soil, patches in which the organic matter is high being black and heavy, while others are light brown and sandy.

The Foster sandy loam is encountered in the bottom lands along the small streams which rise in the Sierra Nevada. Much of the type is overflowed during the wet season and is in a poorly drained condition for several months. For this reason it is used mainly for native hay. A few small areas with better drainage have been planted to truck, small fruits, and alfalfa, to which crops they are

well adapted. Wild grasses grow luxuriantly in the poorly drained areas, and it is probable that the greater part of the type will continue indefinitely to be used for hay production. With drainage all the type is well adapted to intensive farming

Foster sandy loam, dark-colored phase.—The surface soil of the Foster sandy loam, dark-colored phase, is a dark-gray or brownish-gray to black sandy loam, highly micaceous and friable. The subsoil is similar to the soil, and extends without change to a depth of 6 feet or more.

This phase occurs in small bodies along the footslopes of the Sierra Nevada Mountains, as moderately to gently sloping alluvial fans. The soil receives a good supply of moisture by seepage from higher areas and to this fact is due its high organic-matter content and dark color. The lower areas sometimes merge with recent lacustrine deposits or lake-terrace material, and may be swampy

The deep, friable nature of this soil, its high content of organic matter, and its good water supply render it well adapted to intensive cultivation. The topographic position is favorable for fruit production and it supports numerous small orchards. Apples and pears produce well The soil is also well adapted to alfalfa and truck With the exception of the small orchards, it is now largely in grain or grass land.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical and dark-colored phase of the Foster sandy loam:

Mechanical analyses of Foster sandy loam.

Number	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
573107, 573109	Soil	2.9	17.8	6.3	20.2	11.8	21.8	19.1
573108, 573110	Subsoil	2.3	16.6	7.4	20.3	13.0	32.9	7.8
Dark-colored phase:								
573162	Soil	14.4	18.0	4.0	22.4	15.6	14.4	10.2
573163	Subsoil	11.0	16.2	7.0	25.4	21.6	14.3	3.4

STACY GRAVELLY SANDY LOAM.

The Stacy gravelly sandy loam consists of 12 inches of light-brown to brown sandy loam of friable structure, containing varying quantities of gravel of basic igneous rock. The subsoil is similar in character to the surface soil, or somewhat more gravelly or stony. It is loose and easily penetrable by plant roots, and continues so to a depth of 6 feet or more, except along the margins of areas where older, light-gray, calcareous materials of the Lehontan Lake beds underlie the soil at shallow depths. The subsoil is sufficiently re-

tentive of water to favor the development of deep-rooted crops. The soil is fairly well supplied with organic matter. Areas occur in which the soil and subsoil are quite sandy.

The type occurs along the base of the lava plateau and the hills to the north of the valley. It has been derived from alluvial fan deposits laid down by streams and small intermittent drainage ways rising in the hills. Small scattered areas occur between Willow Creek and the State line and about Stacy. Two small areas are mapped in Long Valley, at the mouth of a small canyon, draining an area of hills of complex geologic nature, but consisting mainly of basic igneous rock. The fans occupied by this type are gently sloping and are well drained. Air drainage is fair to good, giving in most cases good frost protection.

At present, most of the type supports a thrifty growth of sagebrush. A very successful garden has been cultivated for several years on this soil, and it supports a small orchard of thrifty young fruit trees of several kinds and a number of grapevines. A field of alfalfa which gives fairly heavy yields was noted in the course of the soil survey. The type needs irrigation for intensive development.

As mapped, the Stacy gravelly sandy loam includes a stony variation, indicated on the map by stone symbols. This occurs in areas of alluvial fans, where the soil contains a high percentage of large rock fragments. The heavy growth of sagebrush on this soil indicates that despite its rocky nature it has sufficient fine material and sufficient depth of soil to be very productive. Much of it, however, occurs at such an elevation as to be beyond any practical system of gravity irrigation. On account of this fact and its very rocky surface this land will probably not be developed for many years. The sloping topography and deep nature of the soil render it otherwise well adapted to orchard fruits.

Below are given the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Stacy gravelly sandy loam:

Mechanical analyses of Stacy gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
[illegible]	Soil	7.4	[illegible]	7.0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Subsoil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STACY LOAM

The Stacy loam has a light-brown or brown surface soil grading into a subsoil of the same or slightly lighter color. In texture the soil is prevailingly a loam, though tending in some places toward

silt loam and in others toward fine sandy loam. Local depressions include small undifferentiated bodies of a heavier adobe soil. Typically the soil is friable, retentive of moisture, and well supplied with organic matter.

With the exception of two small areas east of Willow Creek, the type is confined to the delta of Skedaddle Creek. This creek has built up a large, gently sloping fan which extends from the hills north of the valley out over the old lake sediments of the Lahontan series. The material in the northern part of this fan is over 6 feet in depth, but in the southern part it is underlain by the old lake-laid materials at depths of 3 to 6 feet, and along the margin the soils blend with the Lahontan series. The soil and subsoil absorb moisture readily, but are typically well drained and well aerated. The lower areas, however, have only fair surface drainage and limited subdrainage. In the areas of shallower soil alkali is sometimes present in the subsoil and is likely to accumulate at the surface after the introduction of irrigation, as the lake-laid deposits may be so impervious as to interfere with internal drainage. The higher areas of the type have sufficient slope to assure some air drainage. Low-lying areas are subject to early and late frosts.

Little of the type is under cultivation. The deeper, better drained areas support a growth of sagebrush and the lower areas a growth of sagebrush and greasewood. A small acreage is devoted to truck crops and potatoes, which are irrigated from wells. Potatoes are reported to yield as much as 200 sacks to the acre and other crops do equally well. Alfalfa has been grown, but at present the uncertainty of the water supply makes its cultivation unprofitable. With an adequate supply of water all these crops could be profitably grown on a more extensive scale.

PRESTON SAND.

The soil of the Preston sand is typically light brown to brown, with light grayish brown variations. It consists of a loose sand which is uniform to a depth of 6 feet or more. The texture, however, is subject to considerable variation. The soil may contain an appreciable amount of fine material which has been blown up with the sand, giving almost a sandy loam texture. Such material occurs on the dunes on Honey Island. In other places the wind-laid material may be less than 6 feet deep and may be underlain by finer textured deposits, as is the case in occasional small spots within and along the margin of areas of the type. Any considerable areas of soil of this character are separated as the Preston sand, shallow phase.

By far the greater part of this type occurs in one large area about Doyle. The remainder occurs in scattered bodies around Honey Lake

and in other parts of the area, representing terraces reworked by wind, wind-laid material along old and present beach lines, and scattered rounded or abrupt dunes. The topography of these areas is irregular. That of the large body at Hayt is undulating to broken; the smaller areas consist of steep dunes or have a gently rounded to flat surface. In the higher lying areas, including the large body around Hayt, the drainage is excessive. In some of the smaller areas drainage is not well developed, and along the shore of Honey Lake the type includes areas of sandy beach entirely without drainage.

Owing to the irregular topography, the tendency of the soil to drift, and the lack of water for irrigation the type is not cultivated. All the higher, better drained areas support a growth of sagebrush and rabbit brush, and the lower areas and present beach dunes greasewood and saltbush. Irrigation is essential to the improvement of the type. The loose, coarse soil allows water to percolate freely, so that the type requires an abundant supply of water and frequent light irrigation. Leveling is necessary to fit the land for the application of water. Protection against drifting is also necessary. With these improvements the soil would probably prove well suited to alfalfa.

Small areas of this soil on the Island contain accumulations of alkali. In places here salt has been blown in with the soil material and, owing to the very slow leaching process resulting from the light rainfall, has not been removed. Areas of beach sands which are without drainage also show the presence of alkali. The remainder of the type is entirely free from alkali.

Preston sand, shallow phase.—The Preston sand, shallow phase, is the result of complex conditions of soil formation. The phase includes areas of old lake-laid soils, consisting chiefly of material corresponding to the Lahontan silty clay loam, over which thin layers or dunes of sand have been spread by the action of wind or the combined action of wind and water. This covering of sand may be in the form of irregular dunes several feet high, interspersed with areas of unmodified lake-bed material, or it may be a fairly continuous layer of sand ranging from several inches to 2 feet in thickness. The sand is brown to light grayish brown in color and is uniform throughout its depth. The material underlying the sand is for the most part similar to that of the Lahontan silty clay loam, but includes materials corresponding with other heavy, lake-laid soils. The sand is loose and is still drifting.

This phase occurs chiefly to the southwest of Calneva and in other scattered bodies. The surface is slightly irregular to level, with the greater part fairly level to gently sloping, but marked by some small dunes. The drainage is fair to poor. The lower areas in some

cases are almost without natural drainage and owing to this fact and to the alkali content of the subsoil are unfit for irrigation.

At present most of the area of this phase is uncultivated, and is covered with a growth of greasewood, saltbush and sagebrush. A few small areas are cleared and planted to grain or poorly farmed to other crops. The introduction of water for irrigation is essential to further development, and in the better drained areas irrigation should prove successful with leveling of the dunes and protection against drifting. Where there is but a thin layer of sand, the underlying heavier material might be mixed with it by deep plowing so as to produce a friable loam or sandy loam which would be absorptive and retentive of moisture, and not subject to movement by wind action. The calcareous nature of the underlying Lahontan material would give a soil rich in lime and well suited to alfalfa.

PRESTON CLAY ADOBE.

The surface soil of the Preston clay adobe is brown to rather dark brown, having in places a reddish tint. When wet it is very sticky and upon drying it checks, forming the deep, jagged cracks typical of true adobe soil. The subsoil is similar to the surface soil.

The type occurs northwest and south of Calneva. The material is the result of the removal by wind of clay pellets from the bottom of the lake or playa and their accumulation in the form of dunes.

The type is mapped as spotted with alkali. Apparently salts have been blown out with the soil in some cases, while in other places the material is salt free. Owing to the very slight rainfall of the region the soluble matter has not been leached from the soil. The topography makes irrigation, which is essential to the development of the type, impracticable. The entire area is covered with greasewood.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Preston clay adobe.

Mechanical analyses of Preston clay adobe.

Number	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
[illegible]	Soil	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Subsoil.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ROUGH STONY LAND.

The mountainous soils of mainly nonagricultural character are mapped as Rough stony land. This type as outlined includes small areas suitable for agriculture, but in general the land is so rough and stony that no important development is possible.

ALKALI.

Large areas of alkali land occur within the area surveyed. This fact has been disregarded in many of the proposed schemes for development of the Honey Lake Valley, with the result that its productive capacity has been, in many cases, overestimated.

A classification of the affected areas was made during the course of the soil survey. The results of this work have been embodied in the alkali map, Plate C.

For the purposes of this classification the affected areas were placed in four groups, according to the following criteria:

First group.—Land containing an average of less than 200 parts of salts per 100,000 of air-dry soil, or 0.2 per cent of soluble salts in the 6-foot column, and without local areas or spots of higher concentration. Land of this grade is shown on the map by letter symbol *F*. It is considered free from injurious amounts of alkali.

Second group.—Land in which a concentration of salts in excess of grade *F* occurs in spots. Such lands are usually referred to as "spotted," and while fair crops may be grown the condition is indicated by the occurrence of local barren or unproductive spots. (Symbol, *S*.)

Third group.—Land containing an average of 200 to 500 parts per 100,000, or from 0.2 per cent to 0.5 per cent of soluble salts in the 6-foot column. Land of this grade is unproductive for general purposes, but may produce partial yields of the more alkali resistant crops. (Symbol, *B*.)

Fourth group.—Land containing an average of more than 500 parts per 100,000, or over 0.5 per cent of soluble salts in the 6-foot column; or land having a concentration of over 1,000 parts per 100,000, or 1 per cent, in the surface foot. Land of this grade is usually barren or supports only alkali-resistant weeds and grasses. (Symbol, *D*.)

The general character of the land, the probability of further accumulation, the presence or absence of the highly injurious black alkali, and the position of the salt concentrations in the soil column were also taken into consideration in the mapping, so that the mathematical limits given above are not in all cases strictly followed. Where the indications are that alkali would accumulate rapidly under irrigation, or where relatively large quantities of black alkali are present, the soil may have been mapped of higher alkali content than the present actual salt content would justify. In case the concentration of the salts occurs in the subsoil and the drainage is good and indications are that the salts would be leached from the soil and removed under irrigation the reverse may be true.

The following table gives the acreage of land of the several grades. From this it will be seen that between 23.5 per cent and 32.6 per cent of the land surveyed contains alkali in sufficient quantities to be injurious to crops:

Areas free from or affected with alkali.

Grade of land.	Acres.	Per cent.
Free from alkali	[illegible]	67.4
Alkali in spots	[illegible]	9.1
200 to 500 parts per 100,000	[illegible]	12.6
Over 500 parts per 100,000	[illegible]	10.9
	[illegible]	

The alkali in the lands of the valley, which consists mainly of sodium chloride, sodium sulphate, and sodium carbonate, has been derived in part from evaporation of saline waters of former lakes, and in part through recent accumulation of the leachings from alkali-bearing soils or rocks. The former condition occurs in the soils of the Lahontan series of the East Side, on the Island, and in other scattered localities; the second condition occurs in the stream bottoms and along the lake shores.

A study of the map shows that the greater part of the soil on the East Side contains alkali and that in much of the affected area the content is sufficiently large to make the land worthless for agriculture under present conditions. Owing to the fact that very little surface drainage water now reaches this land, there is but little accumulation of salts on the surface from evaporation, and alkali crust occurs only in small areas. Tests of the subsoils, however, show them to be highly charged with salts. Large areas have a concentration of over 2 per cent, or 2,000 parts per 100,000, in the fourth to sixth foot. Black alkali forms a small percentage of the total salt content, most of it being common salt. With the application of irrigation water these salts would be dissolved and would tend to concentrate at the surface with evaporation of the moisture, as the area has very little natural drainage and most of the excess water would be removed by evaporation. In the vicinity of Calneva drainage is impossible, as this country may be considered the bottom of a basin. The improvement and irrigation of this land would be very difficult or futile. In the higher areas artificial drainage may be feasible. A very light, sandy substratum, which occurs under the greater part of the soils of this region, facilitates subdrainage. The use of the water of Honey Lake, analyses of which are given in the chapter on irrigation, on these soils, already highly charged with alkali, would be hazardous. Wells in this region also

are frequently so saline that their waters are not fit for irrigation purposes.

Recent accumulations of alkali salts from evaporation of surface and subsoil waters occur in the Susan River Valley and extensive areas are found along the northern shores of Honey Lake. In such cases the salts have been transferred from alkali-charged adjacent lands by drainage waters or from concentrations in the subsoils by movement of capillary moisture from below. In marked contrast to the East Side, the alkali here occurs chiefly concentrated at the surface and extensive areas are covered with white crusts. Relatively large quantities of black alkali occur in spots in these regions. The total amount of salts based upon an average of the 6-foot soil column is sometimes small, but the soil is unproductive, owing to high surface concentration. In the Susan River delta and various other low marshy areas, a condition of high concentration is avoided only by the constant use of large quantities of water which keeps the soil solution dilute. These areas have been mapped as alkali free, but a careful study of the conditions should be made before a change is attempted in the agricultural method, as any modification of the present practice might accelerate the accumulation of salts. To the south of Honey Lake considerable areas of alkali land, the result also of recent accumulation, occur. South of the island lies a large area which has a high water table. Further development of irrigation in the region will probably bring the water still nearer the surface.

In the southern part of the area much of the land in the bottom of Long Valley is spotted or uniformly affected with alkali. This is due in part to recent accumulation and in part to old deposits of salts. The valley floor between Doyle and Constantia is poorly drained and is subject to a high water table, at least during the spring months, when over much of the area the water stands about 3 feet below the surface. This condition has resulted in the accumulation of salts at the surface. Spots of black alkali frequently occur. Level spots on the heavier soils of the higher lands of Long Valley are also affected by alkali. These areas are not extensive and, in many cases, would even improve under irrigation.

The reclamation of the lands containing an excess of alkali, and the prevention of an accumulation of the salts can be accomplished by draining and flooding, where there is sufficient slope and an outlet for the drainage waters. When partially reclaimed the more alkali-resistant crops such as some of the sorghums, sugar beets, and sweet clover can at least then be grown, with improvement in the soil conditions. These crops do not materially take up the excess of salts from the soil, but do improve the physical condition of the soil and aid in drainage through which the dissolved salts are removed.

The attempt to reclaim the lower lying depressions or flats by means of irrigation and flooding without drainage can not be recommended.

The occurrence of impervious strata in the soils favors the accumulation of alkali and makes reclamation difficult. Especially is this true where such a stratum occurs close to the surface. This condition is frequently found in the lake-laid soils of the Honey Lake area. In some cases where such a condition exists, which can be readily ascertained by boring, deep plowing or subsoiling may give some relief. Blasting, it is believed, would not be found effective in any considerable number of cases as the strata are not ordinarily brittle enough to be shattered.

DRAINAGE.

The need for drainage in the area arises from two widely different conditions. First, the alkali lands require subdrainage before they can be developed under irrigation, and second, the marshy lands in the Susan River Valley region and the peaty areas at the lower end of the Susan River delta require artificial drainage to remove a natural excess of water.

For this purpose tile drains are preferable, but the cost of draining the arid alkali lands by means of tile drains would be prohibitive under present conditions. In some cases open ditches could probably be constructed at a cost that would not be prohibitive, and would give considerable relief. With the further development of irrigation in the flat east of Lassen it will be necessary to remove by some means the water accumulating in the subsoil. This could probably be accomplished by means of open ditches leading to Honey Lake. Open ditches may also be found to be the solution of the alkali problem on the floor of Long Valley. Where water is applied to the soils of the East Side, with the exception of the Skedaddle Creek fan, or to the Island, ditching will also be necessary. Unfortunately large areas, especially about Calneva and in the lower part of the Island, have no outlet for drainage.

Some of the lands of the Susan River bottom are so wet as to be naturally unsuited to any except marsh vegetation. Drainage of much of this land is difficult or impracticable, but small areas could probably be improved by the construction of short open ditches. The reclamation of the peaty lands on the lower delta of the Susan River depends upon drainage. These lands are so low that systems of drains with gravity outlets would be impracticable, except in small areas, and it will be necessary to construct levees and to pump the drainage water over them, as has been done successfully in large areas in other parts of the State. With such reclamation these lands should prove productive.

With the introduction of water for irrigation from without the basin the drainage problems would be decidedly complicated. If the annual introduction from all outside sources amounted to 75,000 acre-feet of water, Honey Lake might be materially raised, and, provided large quantities of this water were applied to the lands about Stacy, the water table in the Calneva district would be raised to a height considerably above its present level and a lake would be formed in the Fish Springs Sink. The result of adding water to these natural sinks, which are relatively worthless, would be less serious than the effect on the water table in the areas where the land is relatively level and the subsoils heavy or stratified. In such areas the additional water would raise the ground water level and would probably cause alkali accumulation at or near the surface, making drainage necessary for continued cropping.

The problem of drainage is an important one in the valley at the present time. The extension of irrigation, without strict control of the quantities of water used, will materially increase the area in need of artificial drainage.

IRRIGATION.[1]

The first record of irrigation in the Honey Lake Valley dates back to 1854, to a filing on Smith Creek (now Piute Creek) by Isaac Roop. Since that time many filings have been made on the waters in the various streams and lakes tributary to or near the valley. Irrigation projects have been developed by individuals and under partnership agreements in the Susan River Valley and delta, and at the present time these small enterprises constitute a large part of the irrigation development in the area. Under these systems are irrigated the valley and delta of the Susan River and flats northwest of Honey Lake. Most of the claims to water are based on riparian rights. The method of handling the water is primitive and wasteful and has been a retarding influence in the development of the valley. On the Susan River delta irrigation is accomplished by aid of a complicated network of sloughs which distribute the water over the fields in a haphazard way. During the time of the spring floods this country is entirely inundated. From the land irrigated in this way is harvested a crop of tule hay, yielding probably 1½ tons to the acre. Some fall pasturage also is afforded.

The greatest advance in irrigation in the valley was made when storage was established for the flood waters of the Susan River and

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[1] In the preparation of this chapter the author has drawn upon the following published works:

The Irrigation Problems of Honey Lake Basin, Cal., Wm. E. Smythe, U. S. D. A., O. E. S. Bul. 190. Report of the Conservation Commission of the State of Cal., 1912, p. 119.

U. S. G. S. Water Supply Paper No. 297, Gazetteer of Surface Waters of Cal., Part III, Great Basin and Pacific Coast Streams.

U. S. G. S. Water Supply Paper No. 300, Water Resources of Cal., Part III, Stream Measurements in Great Basin and Pacific Coast River Basins.

the water diverted for the irrigation of the country about Standish. This system was installed somewhat over 20 years ago and has since undergone a number of changes. It is now under the control of the Lassen Irrigation Co. The water rights of the company, after continuous litigation for many years, now seem to be well established. The flood waters are used directly in the spring, but as soon as the flow of the river is reduced, the water from storage in Lake Leavitt, McCoy Flat, and Hog Flat is drawn upon. About 3,000 acres are now watered under the project at a flat rate of $1 per acre. Plans are now under way to develop the system further by building a high-line ditch to carry water to the terraces about Johnstonville. This would bring under cultivation land well adapted to irrigation now lying idle because of a lack of water.

Many small streams rising along the eastern slope of the Sierra Nevada Mountains are used to irrigate small areas of land lying at their base or, in some cases, on the valley floor. Throughout this section seepage from the mountains above and water from springs are also relied on for irrigation. The lands thus irrigated occur from the southern limits of the area through Long Valley and the Lassen Milford country to Gold Run Creek. The water of these streams is either distributed over grass land in the same manner as in the Susan River Valley or is diverted under somewhat more systematic methods to alfalfa fields or small orchards. On the largest of these streams, Baxter Creek, a project for further development of water is now being promoted. Plans are to build a storage reservoir in the Elysian Valley with a capacity of 13,000 acre-feet. This would make available the flood water of the creek for the irrigation of the lands about Lassen and west of Edgemont.

Under the terms of the contracts, not more than 4,000 acres are to be brought under the system and the present plans include 7,500 acres. It is proposed to sell water rights under the system at $50 per acre, payable in annual amounts covering a period of years, the system, when payments are completed, to become the property of the farmers as stockholders in the Farmers Cooperative Association. Up to the present time the project has failed to secure sufficient financial backing. Records of the flow of the creek are not available except for the last few years and the amount of water available is not conclusively shown to be sufficient to supply the demands to be made on it under the proposed project. The only possible sources of water within the valley for these lands are Baxter Creek and Long Valley Creek, and they are entirely inadequate, even when the feasibility of development through storage is assumed. These facts have led those interested to look outside the valley for a source of water. Surveys were carried to the Little Truckee River, but engineering difficulties and prior rights rendered unfeasible the plan to obtain water from this

source. It has also been suggested that water might be brought from the Pacific coast drainage from the Last Chance creeks. There are two Last Chance creeks in Plumas County both tributary to the Feather River. The larger flows into Sierra Valley, the smaller into Genesee Valley. It would be possible to develop water for the Honey Lake Valley from both of them. The smaller creek might be carried through the crest of the Diamond Mountain Block by means of a small tunnel and used to irrigate the lands about Milford. The supply of water obtained would be small and the watershed which could be controlled at this elevation would be inextensive. The larger creek might be stored in Last Chance Valley and from there carried through a tunnel at Chilcoot into Long Valley. The area possible of irrigation from this supply is estimated at 15,000 to 20,000 acres. Whether either of these plans is practicable has not yet been determined.

Many projects having as their object the development by storage of the waters of Willow Creek and its tributary, Petes Creek, have been proposed but none have been carried to completion. The flow of the creek is now discharged on the Susan River delta and forms a part of the water used on the hay lands of that district. Numerous claims have also been made on the water of Balls Canyon Creek, which is a tributary of Willow Creek, with the intention of storage. The watershed in this case is very poor, consisting of barren lava hills which receive very scant precipitation and have little capacity to withhold the run-off. The proposed storage has never been carried out except in a very small way.

Many attempts have been made, since as early as 1892, to finance a project to tap Eagle Lake, lying 10 or 12 miles north of Susanville, and render its waters available for use in the Honey Lake Valley. The plans call for a tunnel some three-fourths mile or more in length and about 1,000 feet have been excavated. This tunnel would empty into Willow Creek, from which the water would be withdrawn a few miles above Standish and conveyed by means of a high line canal to the East Side. Such a canal, known as the Ward Lake Ditch, was actually built but has fallen into disuse. Much of the land intended to be brought under water contains so much alkali that it is worthless under present conditions. The area to be supplied with water—some estimates were as much as 100,000 acres—is entirely out of proportion to the amount of water available. It has been proposed that a part of the flow of the Susan River could be diverted and stored in Eagle Lake. This is believed to be feasible, and if it were done the water supply would be greatly augmented.

No official data have been collected on the flow of Skedaddle Creek. This stream is very irregular. During dry years no water descends

as far as the floor of the valley, though in wet years it may overflow large areas. A dirt dam was built to store the flood waters, but this was washed away and no subsequent attempt to provide storage has been made. The character of the watershed, which consists of barren lava hills, and the uncertainty of the rainfall, make the stream a very unreliable source of irrigation water.

Long Valley Creek represents almost the entire water flow draining into the valley from the south. This creek has a large watershed, but its flow is uncertain, intermittently torrential in character, and the water carries considerable sediment. It has been proposed to store the waters of this stream in Dry Valley, in Red Rock Valley, or in a reservoir to be developed by the "Lone [illegible] Dam," about 6 miles north of Doyle. Some construction work has been done in furtherance of the plan, but the project has never been completed. Storage on this creek is now limited to one very small reservoir at [illegible]. During the flood periods of wet years Long Valley Creek contributes a large volume of water to Honey Lake, but during dry years the flow is small. A conservative estimate of the water annually available for storage is 30,000 acre-feet.

The waters of the hot and warm springs northeast of Honey Lake are used to flood native grass land. The water of the spring at High Rock is used to irrigate an alfalfa field, which after many years of continuous cropping still gives excellent yields.

Two cooperative and several individual attempts have been made to utilize the waters of Honey Lake for irrigation. The Standish Water Co., organized in 190[illegible], installed a large pumping plant on the shore of the lake below Amedee and constructed a system of ditches to furnish water for 6,000 acres of land. Only a small area was cropped under the system, though the results from the experiment, which included sugar beets, alfalfa, and wheat, are reported to have been favorable. The Honey Lake Irrigation Co. constructed a pumping plant and system of ditches on the Island, but have not proceeded with further development. The capitalists interested in these two projects expected to secure title to Government land under the desert act, but were unsuccessful, as the present law of the State makes no provision for securing title to water in lakes which have no outlet.[a] The United States Land Office has ruled in these cases that as the claimants to the land have no title to the water with which they propose to irrigate, they have not complied with the requirements of the desert act. The question awaits the expected change in the California law for settlement, and it seems probable that title will soon be secured. Individuals who have filed on land adjoining the

[a] By section 1410 of the Civil Code of California, relating to appropriation of water, it is stated: "The right to use of running water flowing in a river or stream or down a canyon or ravine may be acquired by appropriation."

lake shore and built pumping plants on their claims which are fed by ditches leading from the lake have succeeded in obtaining title to their land. In general, after securing title, they have not continued development, and although one or two at present are using the lake water, no data relating to the effect of the continuous use of this water for irrigation are available. The salinity of the lake water and its fluctuating volume render such projects dubious, especially when one considers the facts that most of the land which is to be irrigated is slightly to highly charged with alkali, that the soils are heavy textured, and that the drainage[1] is deficient.

Irrigation by pumping from underground waters and from artesian wells has been practiced on small tracts on the East Side. Many wells have been put down in this district, the object in most cases being to obtain title to lands under the desert act, after which they were not further developed. Many of the wells are highly saline.[2]

[1] An analysis by the Dept. of Agr. Chem., Univ. Cal., of Honey Lake water taken in the summer of 1916 when the lake was somewhat above normal height showed the following salt content:

Chemical analysis of water from Honey Lake.

Constituent.	Parts per million.	Grains per gallon.
$NaCl$	642.96	37.29
Na_2SO_4	467.21	26.99
Na_2CO_3	253.67	14.79
$NaHCO_3$	405.60	23.71
$Mg(HCO_3)_2$	73.1?	4.26
$Ca(HCO_3)_2$	81.04	4.70
	2,008.81	116.40

Honey Lake has been dry three times within the memory of white settlers—1859, 1863, and 1903.

[2] Analyses by the Dept. of Agr. Chem., Univ. Cal., of the waters of two wells in this district are given below. Note the wide difference in quality.

Chemical analyses of the water from two wells on the East Side.

Constituent.	Parts per million.	Grains per gallon.
Well No. 1:		
$NaCl$	4,205.57	245.64
Na_2SO_4	1,602.44	93.06
Na_2CO_3	889.34	51.56
$NaHCO_3$	1,253.26	73.48
$Mg(HCO_3)_2$	41.73	2.43
$Ca(HCO_3)_2$	24.30	1.42
	8,526.01	490.30
Well No. 2:		
$NaCl$	49.60	2.88
Na_2SO_4	27.70	1.60
$NaHCO_3$	63.64	3.70
$Mg(HCO_3)_2$	18.39	1.06
$Ca(HCO_3)_2$	34.85	2.02
	194.85	11.30

and unfit for irrigation use. Others give a very unreliable supply. A few are satisfactory both in quality and quantity. Along the base of the lava beds north of the valley, especially about Stacy, is an artesian belt, in which flowing water may be obtained at a depth of about 400 feet. A number of wells have been developed, several of which are now uncapped, although the warm water is not used. A few of the wells are used to irrigate small areas of truck crops. Pumping in the valley is very expensive, fuels costing double the market price at Sacramento and no electric power being available. Because of the quality and quantity of water obtained and the cost of pumping, it is evident that no extensive development in this district can be expected from the use of the underground water supply. Irrigation by pumping from wells is being attempted also in the vicinity of Leavitt. It is said that a plentiful supply of good water can be obtained in this vicinity.

After a careful study of the water resources of the Honey Lake Valley and of soil and climatic conditions, the following conclusions seem warranted: With the exception of a few areas of soil along the base of the Sierra Nevada Mountains irrigation is essential for intensive agriculture. A large part of the valley land can not be relied upon to give profitable yields under dry farming, even of extensive crops such as grain. Susan River and its tributaries afford a reliable source of water for the irrigation of the northwestern part of the valley provided more economical use is inaugurated. An effective development of the waters of Eagle Lake would probably furnish a supply sufficient to irrigate all the remaining lands lying on the northern side of the valley, including the lands about Stacy that do not contain so much alkali as to render them unfit for cultivation. The remaining lands of the valley are without water supply for irrigation, except small areas along the western edge, irrigated from streams rising in the Sierras and from springs, and other more extensive areas capable of irrigation by pumping from an underground source or from artesian wells.

Recently there has been considerable agitation concerning irrigation development in the valley. During the winter of 1915 the water resources of the valley were partially investigated by the United States Reclamation Service.

The methods of irrigation at present used in the valley are unsystematic, consisting simply of getting the water on the land in the quickest and easiest way possible. Checking of alfalfa fields is practically unknown. In a few small orchards and gardens irrigation by furrows is practiced.

No data are available from which to determine the correct amount of water for most crop production in the valley. The duty of water under the present systems of irrigation is very low, especially in

the delta region. It is this wasteful use of water that has been an important factor in retarding the growth of the valley. As in the delta, the present duty of water on the mesa lands is very low—surprisingly so when one considers the difficulties that have been overcome in obtaining water. This wasteful use has resulted in the ruining of some of the lower lying areas. Prof. Frank Adams,[1] in making his estimates of the water possibilities of the valley, supposes a duty of 1.5 acre-feet under direct use and 2 acre-feet under storage. The Baxter Creek project was estimated on a basis of a duty of 1.5 acre-feet. The correct duty undoubtedly varies very much, depending on the character and location of the soil. Some of the sandy soils require large amounts of water, while large areas of heavy textured soils will produce maximum crops with much less. The soils along the western side of the valley require less water per acre than those of the east side of similar character, as there is a decided advantage in favor of this locality in the amount of precipitation.

SUMMARY.

The Honey Lake area has an extent of 529 square miles, or 338,560 acres, lying within and adjoining the Honey Lake Valley in southeastern Lassen County, Cal. The average elevation is approximately 4,000 feet above sea level. The greater part of the area is included in the Great Basin region, Honey Lake Valley representing the lowest part of the Honey Lake Basin, an arm of ancient Lake Lahontan. Honey Lake, lying in the valley, receives the drainage of the greater part of this basin.

The area has a varied topography ranging from level on the valley floor to rough mountainous in the foothills along the margin.

The principal town in the valley is Susanville, with a population of about 1,000. The population of the area surveyed is about 2,000. Good transportation facilities are furnished by the Southern Pacific, the Western Pacific, and the Nevada, California & Oregon Railroads, the latter a narrow gauge line.

The Honey Lake Basin and adjacent eastern parts of the area comprise a desert region, arid, and covered only with sagebrush or other desert vegetation. The Sierra Nevada and foot slopes are subject to greater precipitation and are in part forested.

The climate differs materially from that of the greater part of California. The eastern part of the area is arid and the western part semiarid. The winters are moderately cold but not severe. During the summers the days are warm but the nights are cool. The length of the growing season varies widely in the different sections; in general, it is shorter than over most of California.

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[1] Irrigation Resources of California and Their Utilization, United States Department of Agriculture, Office of Experiment Stations, Bulletin 254.

The first permanent settlements in the area were made in the early fifties. Agricultural development has been slow, and has been restricted by lack of water for irrigation.

Less than 25 per cent of the land of the area is under cultivation. Practically no intensive farming is now practiced. Alfalfa and wild hay are the principal crops. Dairying based on alfalfa and improved native meadow promises to become an important industry. The hay is now mainly fed to range cattle. Other crops are of minor importance. The hardier fruits are grown locally and alfalfa seed is produced to some extent, and the development of certain intensive farming crops with the raising of hogs and other live stock offers good opportunities in some sections.

The soils are classed under seven general groups: (1) Those derived from residual material, (2) those derived from old valley-filling material (chiefly Lahontan Lake beds), (3) those derived from material of the Lahontan beds modified by chemical precipitates, (4) those derived from recent lake deposits, (5) those derived from recent alluvial fan and stream bottom deposits, (6) those derived from wind-laid deposits, and (7) miscellaneous material. In extent the old valley-filling soils are by far the most important, but are not extensively utilized. The recent lake-laid soils and recent alluvial soils support a large percentage of the present agriculture.

The first 6 general soil groups include 13 soil series and 34 soil types. An additional type of nonagricultural material, Rough stony land, is also mapped.

The soils of the first group are represented by the Holland and the Olympic series; those of the second group by the Johnstonville, Standish, Lahontan, and the Truckee series; those of the third group by the Churchill series; those of the fourth group by the Carson and the Buntingville series; those of the fifth group by the Hanford, Foster, and the Stacy series; and those of the sixth group by the Preston series.

The Holland series includes types with brown soils derived from quartz-bearing crystalline rocks. It is represented by a single type, of coarse sandy loam texture, with a dark-colored phase. Much of the soil is stony and it is of little agricultural importance.

The Olympic series includes types with brown soils derived from basaltic rocks. It includes in this survey but a single type, a stony loam. It is quite extensive, but of little agricultural importance.

The Johnstonville series includes brown soils derived from old Lahontan Lake terraces. The parent material is mainly granitic and derived from the Sierra Nevada Mountains. It is represented by two members, a coarse sand and a sandy loam, with loamy and poorly drained phases, respectively. The soils are not as yet extensively utilized.

The types of the Standish series consist of brown soils occupying Lahontan Lake terraces and derived from materials coming from many kinds of rocks. The subsoils are lighter colored than the soil and calcareous. The sand, stony sandy loam, gravelly sandy loam, sandy loam, loam, and clay loam members occur. They are partly used for dry farmed grains, and where irrigated, to a considerable extent for alfalfa. The irrigated areas constitute some of the most productive land of the survey. Poor drainage and alkali sometimes occur.

The Lahontan series includes types with light gray calcareous soils and subsoils derived from old lake-laid deposits of Lake Lahontan. They occupy extensive desert areas much of which are poorly drained and charged with alkali salts. Some areas are capable of development under irrigation but the soils of this series are not at present extensively farmed. The sand, fine sandy loam, loam, silty clay loam, and clay members of the series are mapped.

The Tuscan series includes types with brown to reddish brown shallow soils and a substratum of cemented or indurated gravel and volcanic tuffs. It is represented in this survey by a gravelly loam type of practically no agricultural importance.

The Churchill series includes material similar to that giving rise to the Standish and Lahontan series, but modified by nodular or hardpan-like deposits of calcium carbonate. It is represented by three members, the sandy loam, stony loam, and loam. They are inextensive and not of great agricultural importance.

The Carson series includes types with dark colored soils and lighter colored subsoils, occupying recent lake bottoms. The soils contain much organic matter and the subsoils are high in lime. Three types, the loam, clay loam, and clay adobe occur in this area. They are extensive, but poorly drained and utilized mainly for the production of wild hay, or as pasture.

The Buntingville series includes types with brown soils and similar in topographic position and origin to the Carson series, but with less calcareous subsoils. It includes three types, the sandy loam, loam, and clay loam. Drainage is poorly developed and injurious quantities of alkali are present in many places. The soils are used mainly for the production of wild hay.

The Hanford series includes types with brown soils and subsoils, of recent alluvial origin, the material coming originally from granitic rocks. They occur principally as alluvial fan deposits at the foot of the Sierra Nevada Mountains and are well drained. Their area is not extensive, and owing to lack of water for irrigation little use is made of them. The coarse sand, stony sandy loam, gravelly sandy loam, and sandy loam members are represented.

The Foster series includes recent alluvial types with dark-brown soils. The materials have been washed from granitic rocks. The types occupy minor stream bottoms and alluvial fans extending from the Sierra Nevada Mountains. Only the sandy loam member with a dark-colored phase is mapped. It is of small extent. Some of the land is used for wild hay, alfalfa, and truck and orchard crops.

The Stacy series includes types with brown soils and subsoils, occupying recent alluvial fans, and derived from material washed from basaltic and andesitic rocks. The gravelly sandy loam and loam members of the series occur in this area. They are well drained, but of little present agricultural importance owing to lack of facilities for irrigation.

The Preston series includes types with light-brown to brown soils of wind-laid origin. The sand and clay adobe types, the latter formed by small clay pellets heaped up into dunes by winds, are mapped. The former is extensive, but not utilized.

A large proportion of the area is affected by alkali. The lower parts of the valley are poorly drained. These two factors limit the value of much of the land in the valley.

Irrigation is necessary for intensive cultivation in the western part of the area, and is essential to any kind of farming in the central and eastern parts.

Irrigation as now practiced is very wasteful. Water for irrigation of only a small part of the valley has been developed. Further extension of agriculture in the valley depends upon the development of water for this purpose.

[Public Resolution No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture. Second. That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

Areas surveyed in California

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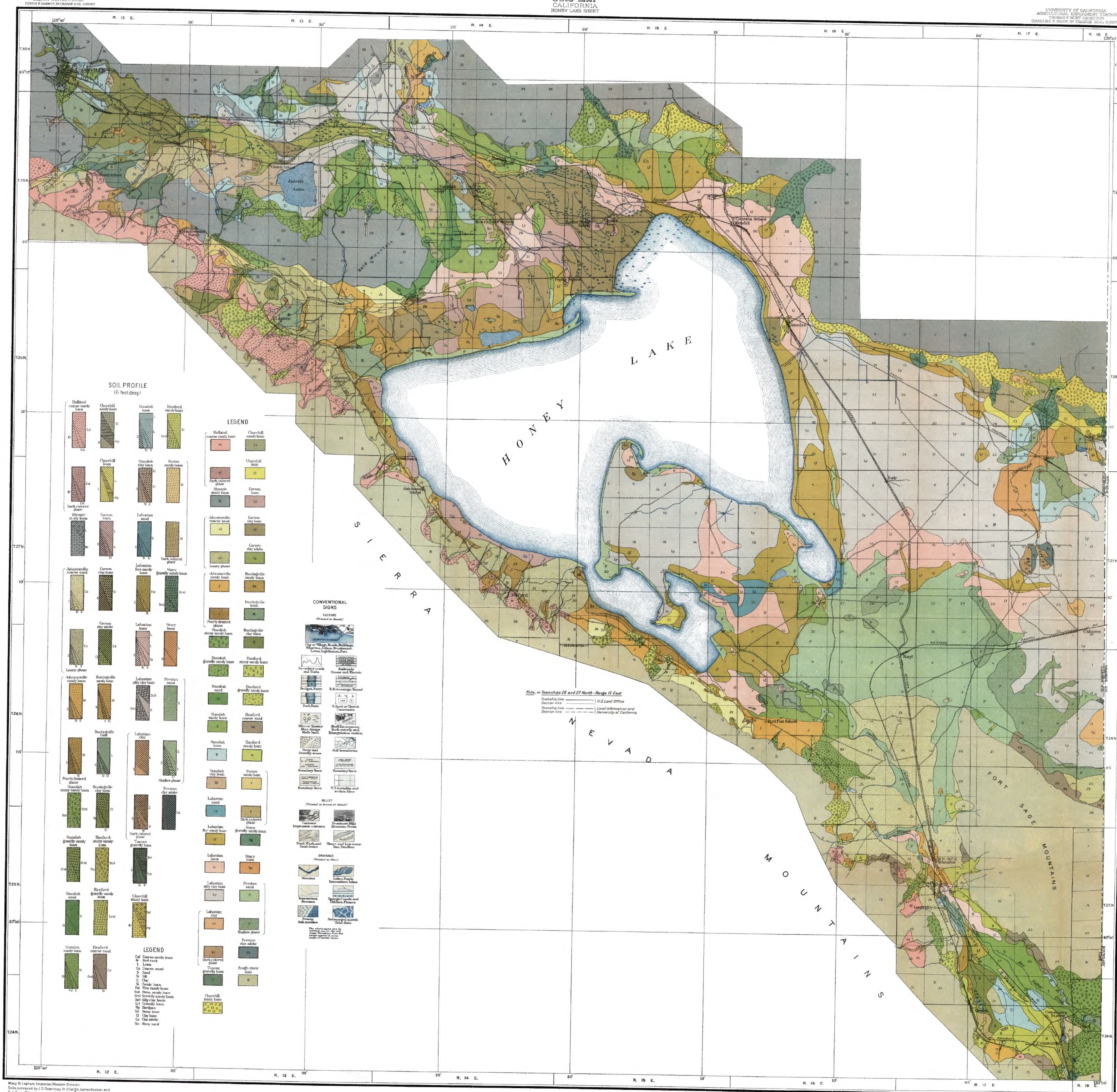
U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

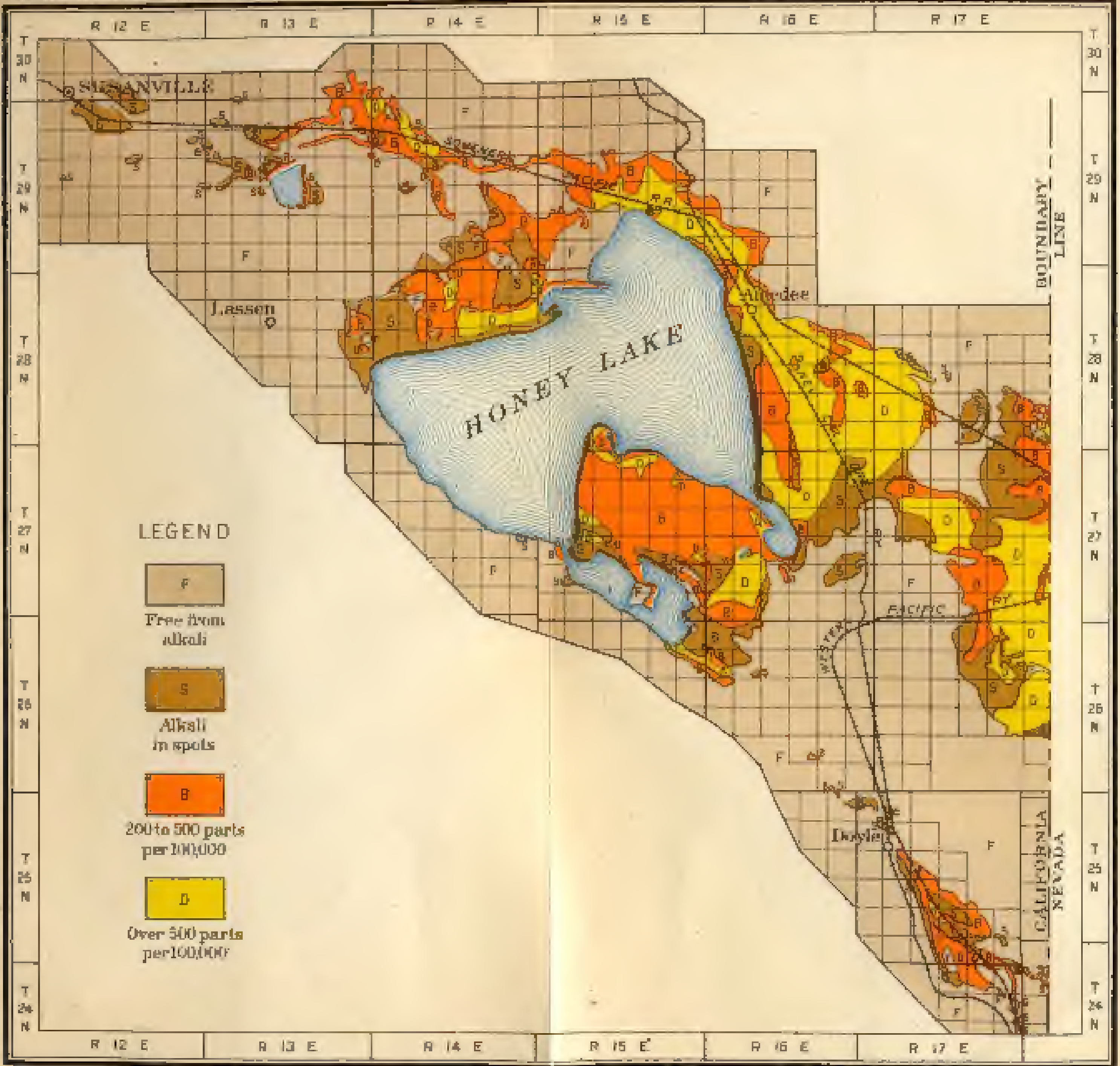
SOIL MAP
CALIFORNIA
HONEY LAKE SHEET

UNIVERSITY OF CALIFORNIA
AGRICULTURAL EXPERIMENT STATION
THOMAS F. HUNT, DIRECTOR
CHARLES F. SHAW, IN CHARGE SOIL SURVEY



Macy H. Lapham, Inspector, Western Division.
Soils surveyed by J. E. Guernsey, in Charge, James Koeber, and C. J. Zinn, of the University of California, and E. C. Eckmann, of the U.S. Department of Agriculture.

Field Operations
Bureau of Soils
1915



SNYDER & BLACK N.Y.

ALKALI MAP OF HONEY LAKE AREA, CALIFORNIA.